Hook, Line and Stinker!

The Truth about Fermented Cod Liver Oil

Kaayla T. Daniel PhD

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INTRODUCTION

It's brown. It stinks. It burns people's throats. And its taste has been described as "downright nasty."[1-6] It's the Green Pasture brand "fermented cod liver oil" (FCLO), a unique product said to be the one and only truly traditional cod liver oil. It hit the market in 2006, and — thanks to the endorsement of Sally Fallon Morell — quickly captured the loyalty of thousands of people in the paleo, primal and Weston A. Price Foundation communities.

Believers promote it as the only true "traditional" cod liver oil, the "high vitamin" cod liver oil recommended by Dr. Weston A. Price DDS, and the very secret to the superpowers of the Vikings. It's recommended for pregnant women, babies, and children of all ages. People facing health challenges *know* they should take extra in the belief that something that tastes so bad must really be good. In only nine years, FCLO has become nothing less than the "real food" community's secret to optimal health, high energy and maximum longevity.

The Word is that babies and children won't grow well without it.[7] Parents on Facebook forums share tips on how to squirt the brown liquid down the throats of protesting babies and how to scrub the inevitable brown stains off bibs and clothing. And those who cry that FCLO is too expensive for their budgets are urged to prioritize it over everything else, including the buying of organic, pastured and free-range foods. Parents whose gut instincts tell them to stop feeding it to their children find themselves guilt-tripped with statements like "You'd find a way if your child needed to take a prescription medication, wouldn't you?"[8]

Those few people who've questioned whether oil can even be fermented, or if the smell and color might signify rancidity, find themselves shushed and shunned. Their concerns have been summarily dismissed as ignorant, unfounded, disproven by science, seriously misinformed, and the slanderous disparagement of unethical and jealous competitors.[9-13] To which, a few people have dared to push back with words like "The nose KNOWS!" "What's become of common sense?" and "Show me the science."

In short, lines have been drawn. FCLO is either a true miracle food given to us by David Wetzel, a farmer/saint from Nebraska[14] Or a case of the Emperor's New CLO.

* * * * *

Last summer, the FCLO flap caught my attention and I became curious enough to start investigating. I talked to colleagues with expertise in fats, oils, fish and fermentation, took a long look at the history and research, and talked to doctors, nutritionists and other health practitioners who had used FCLO in their practice. I went into the project expecting to find evidence that would reconcile the adversarial “either/or” positions into a more peaceful “both/and.” I believed FCLO would be right for some individuals, wrong for others. After all, how could so many health experts be wrong?

As I reeled in the evidence, I came to believe there was something seriously wrong with FCLO. I thought the Weston A. Price Foundation should get to the bottom of it, and advised Sally Fallon Morell that we needed to test the Green Pasture Fermented Cod Liver Oil product properly and not just rely on David Wetzel’s assurances and his testing. I expressed concerns to her and later to WAPF’s Board of Directors about probable rancidity and possible putrefaction, and said I was skeptical of data showing improbably high levels of Vitamin D2 in the product. I furthermore shared reports from clinicians who were finding severe Vitamin D deficiencies among some members who were regularly taking FCLO. As Vice President of WAPF, I felt the safety of our members and the credibility of the foundation were at stake.

In December 2014, WAPF’s Board of Directors voted against testing based on Sally Fallon Morell’s beliefs, David Wetzel’s assurances, and scientific data of limited and questionable value. I was strongly advised to relax, leave the science to people who could be “fair to Dave” and to toe the FCLO line.

Instead I went underground and set out on my own to test FCLO at some of the world’s top laboratories. Though my initial concerns had been rancidity and nutrient density, I soon realized there might be far bigger fish to fry. FCLO might be adulterated. And it might not even come from cod!

* * * * *

In early February, I sent newly purchased, unopened bottles of unflavored FCLO off to five laboratories in the United States, Norway and the Netherlands for testing. Later, when Green Pasture’s cattle lick product became available for purchase, a sample of the liver went off for DNA testing. I sought answers to a dozen key questions:

- Is it cod?
- Is it wild or farmed?
- Is it from the arctic?

- Is it unadulterated? Nothing added?
- Have antioxidants been added?
- Does it have high levels of the fat soluble vitamins A, D and K?
- Is the Vitamin D mostly D3 or D2?
- What are the levels and ratios of EPA, DHA and other fatty acids?
- Are *trans* fats present?
- Is it fermented?
- Is it rancid?
- Is it putrid, with unsafe levels of tyramine, histamine, cadaverine and other biogenic amines?

In short, does FCLO have integrity? Is it as advertised? Is it whole, natural, safe and nutritious?

What is the truth about fermented cod liver oil? This is a preliminary report, with more research needed and considerable funding required. But right now it looks like consumers have been hooked on a whopper of a fish story.

* * * * *

ENDNOTES

1. "God help me . . .that stuff is NASTY. . ." http://bit.ly/1J3T2QK

2. "When the new fermented cod liver oil arrived, I was surprised to see that it was very thick, very dark, and had a very foul odor. I went ahead and tried one dose; it was absolutely disgusting! It burned my throat. . . ." http://bit.ly/1JqWZ5r

3. "It tastes nasty (especially the fermented type). Over time, I think I've just gotten used to it and can swallow it without too much problem." http://bit.ly/1ECx4jP

4. "After my first attempt at downing the stuff, I promptly spent the day gagging as the flavor continued to revisit my palate. Only recently have I gotten to the point where I can smell my kids' FCLO without feeling ill." http://bit.ly/1J4eHpJ

5. "Nastiest tasting pills ever," "yucky," "pukey" and hundreds of other comments on the taste, odor and other sensory properties of FCLO can be found in reviews of the Green Pasture products posted at www.amazon.com. There are also many comments that it's "not that bad," "tolerable," "manageable" and "worth it."

6. “Hard as I tried, I found myself unable to tolerate the cod liver oil after a short time taking it, I found its burning sensation as I swallowed it so intensely painful I gave up on it. I figured that my body somehow couldn’t tolerate it, or wasn’t ready for it.” http://bit.ly/1Pzwwl1

7. Discussions about FCLO — some of which get quite heated —can be found in the comments section of various “real food” blogs, Facebook groups and Weston A. Price chapter leader forums, and especially at www.nourishingourchildren.com and in the Facebook groups Nourishing our Children and Nourished Children.

8. Video by Sarah Pope, The Healthy Home Economist. “How to best swallow cod liver oil.” http://bit.ly/1K5VXub The video is also posted at balancedbites.com, greenpasture.org and other websites.

9. Author’s conversations with people at Wise Traditions, NTA, Paleo f(x), Ancestral Health, NTA and other conferences. Also, comments written online in forums and support groups, including those noted above.

10. Posts and comments at the Facebook groups Nourishing our Children and Nourished Children as well as other online groups and forums, including a comment posted by Sandrine Love at the Nourished Kitchen blog that says, “To say that this cod liver oil is rancid and putrid is slander. You can post this. Sally.” http://nourishedkitchen.com/benefits-of-cod-liver-oil/

11. Comments at Chris Kresser’s website— http://bit.ly/1ECxjeB —including, “The whole notion of fermenting cod liver oil is misguided,” “fermented-ness is not a quality of the oil,” “fermented cod liver oil isn’t really fermented at all, it’s rotted,”and the “product is misbranded.”

12. Comments at the Nourished and Nurtured blog — http://bit.ly/1JqWZ5r — including praise for Sarah Smith: “You are a brave woman! FCLO (fermented cod liver oil) is such the rage for members of the WAPF.”

13. Gumpert, David. “Simmering Cod Liver Oil Imbroglio Heats Up for WAPF Conference” http://bit.ly/1Pzwwl1

14. A particularly good example of this comes from Sandrine Love at http://bit.ly/1hjqtpA . Her article concludes with the words: “Meanwhile, thank you, David and Barbara Wetzel for restoring the ancient art of fermented cod liver oil production and for providing us with this sacred food. I celebrate you, David Wetzel. I would like to give you a standing and prolonged ovation for the life you lead, for the inspiration you offer, the integrity and values you uphold, the grace and generosity of spirit you possess, and the love that you offer freely to those who are blessed to cross your path.”

SECTION I
THE "F WORD" — FERMENTATION

It's brown and it smells, but believers in FCLO insist that it's not rancid but "fermented," a process said to dramatically increase its vitamin content, improve its digestibility, and miraculously protect the fragile omega 3 polyunsaturated oils found in cod liver oil from rancidity.[1-3] Indeed, David Wetzel goes so far as to say that his product does not need antioxidants and only gets better with age![4,5]

Sorry to burst that bubble, but lab testing shows FCLO has not been safely preserved by fermentation — and may not have been produced by fermentation at all.

BUBBLE RAP

Lactic acid fermentation is a traditional method of food preservation used to produce foods such as sauerkraut, kvass, kimchi, kombucha, beer, wine, pickles, and sourdough breads. Lactic acid bacteria metabolize sugars and other carbohydrates in food in an anaerobic environment and produce the acidic environment that is needed to kill or inhibit the growth of pathogens and to prevent the production of bacterial toxins. If done properly, the process not only assures food safety but preserves and increases the content of vitamins; improves digestibility; and imparts the distinctive sour, tart and mouth-puckering flavors associated with fermented foods.[6-12]

The idea that cod livers could be fermented is ludicrous on the face of it. Lactic acid bacteria show a stunning capacity to degrade different carbohydrates and related compounds into the primary end product of lactic acid. But they have a very limited capacity to synthesize the amino acids of protein and none at all to synthesize fats.[13]

Fermentation requires carbohydrate, which is why it is most often associated with vegetables, grains and dairy. While it is true that some cultures also ferment fish and meat, the process requires some sugar, typically supplied through acid mari-

nades or rubs and/or the addition of carbohydrates such as rice. Processes that preserve fish and meat primarily through salt are generally called “curing.” Fish sauces such as the garum and liquamen favored by the ancient Romans are made by layering whole fish with copious amounts of salt and draining off the liquid, which is a separate product from the oil.[14-16]

The fact is, cod livers are ill-suited to fermentation because they lack sufficient carbohydrate. According to figures from the National Food Institute in Denmark, 100 grams of cod liver contain 55.1 grams total fat, 4.5 grams of protein and only one gram of carbohydrate.[17] The website FitBit reports 44.2 grams fat, 9.3 g protein and 2 grams total carbohydrates.[18] Figures for pollock and other fish livers are not readily available, but probably about the same.

The Green Pasture line is that it is “fermenting” the livers rather than the oil itself and that the name “Fermented Cod Liver Oil” is just easier to say than “The Oil from Fermented Cod Livers.”[19,20] The disclaimer doesn’t alter the fact that the process of “fermenting” livers has to involve oil and protein. Conceivably a little “fermentation” could occur with that one or two percent carbohydrate, but it would be a stretch to describe the overall product as “fermented.” And if anything in there ever does ferment — and that is a big *if* — the pH needs to be acid enough to preserve it and prevent spoilage.[21]

ACID TRIP

True lacto-fermented products are acidic with a pH under 4.6.[22] The pH of FCLO is 5.17 as reported by Lab #1 and 5.8, as reported by Lab #2. Wetzel has said on several occasions on videos and in conversation that the pH of FCLO is even higher, at 6.1 or even 6.2. So whether or not the oil was actually obtained through “fermenting”of the livers, the evidence is in that it’s not being preserved by an acidic pH.

IN SEARCH OF WEE BEASTIES

Fresh lacto-fermented products would also show a lively population of lactic acid bacteria ranging from 1 million to 50 million cfu (colony forming usints) per gram of lactic acid. Lab#2 reported lactic acid bacteria in FCLO at levels less than 10 cfu (colony forming units) per gram. Furthermore, testing at Lab #4 showed non-detectable levels of homofermentative and heterofermentative bacteria, two categories determined by the products and patterns of fermentation. The homofermentative process produces lactic acid as its sole end product while the hetero-

fermentative process produces lactic acid, carbon dioxide and ethanol/acetate.[23,24] Asked if the product might once have contained live bacteria, the microbiologist at Lab #1 said he had no way to test for that possibility.

Levels during active phases of fermentation should be anywhere from 1 million to 50 million cfu/g, but as the food supply is exhausted, the bacteria die off and their numbers drop to non-detectable levels. Changes in temperature, moisture, heat and pH of the environment can also contribute to die off. This is true, of course, with sauerkrauts and other cultured foods as well. However, such products remain preserved because the pH is an acidic 4.6 or lower. While it's true that some genuinely fermented products have a higher pH, they must undergo pasteurization or some other form of treatment to prevent spoilage and to ensure food safety.[25]

Given that Green Pasture "ferments" the livers and not the oil, the very low levels of lactic acid bacteria were to be expected. Even if the oil were being fermented — or "pre-digested" as Wetzel has been wont to say — any bacteria would have quickly eaten up that one or two percent carbohydrate and died off early on. Unless, of course, Green Pasture has added other carbohydrates to keep fermentation going, a possibility that will be discussed shortly.

On a more positive note, lab testing showed no contamination of FCLO by unwanted microbes. Lab Report #4 shows negative or non detectable levels for *E coli*, total coliforms, salmonella, staphylococcus aureus, yeast, mold, listeria, or other pathogens. Of course, the likelihood that any microbes could survive in any oil without moisture is slim.[26,27]

VAT'S UP?

Producers of fermented foods typically use "starters" to ensure reliability and reproducibility, to attain the desired flavor, and to better control the rate of fermentation. Wetzel has shared videos that show rows of white containers labeled "starter" and he says Green Pasture has "developed an inoculant for our fermenting work" that has "taken much time through selection."[28] But what's actually in there is anyone's guess. Is the Green Pasture starter teeming with the lactic acid bacteria needed for rapid acidification of the raw material? Does sugar serve as a carrier for those bacteria? What about whey? How about salt? And is Green Pasture actually using its own unique and secret formula or could it be buying a readymade starter culture targeted for the food fermentation industry? If the latter, it may well contain antimicrobial substances, sugar polymers, sweeteners,

aromatic compounds, vitamins, enzymes, as well as the expected lactic acid bacteria.[29]

Given that liver contains extremely low carbohydrate content, any attempt to keep fermentation going would require plenty of carbohydrate in the recipe. Does Green Pasture add in such carbohydrates? If so, what?

And is Green Pasture "fermenting" in air-tight vats? Photographs show a large building with a greenhouse-like glass roof and vats with top openings that appear to be tightly sealed with opaque lids. Tim Boyd, writing for the Weston A. Price Foundation's website, confirms "air-tight vats."[30] Wetzel seems on board with this, yet also likes to talk about his "solar facility" and how his "all natural" products benefit from exposure to the sun, moon and stars.[31] Will the real process please stand up?

Not surprisingly, professionals who've researched fermentation and brought lactic acid fermented products to the market have been curious about his procedures. But those who've asked Wetzel about his signature process report inconsistent, contradictory, confusing, disrespectful, and even nonsensical answers. Similarly, homemakers who enjoy fermenting sauerkraut, kimchi, kvass and other bubblies on their kitchen counters have visited Wetzel's booth at conferences to ask for tips on how to make fermented cod liver oil at home. Instead of a straight answer, Wetzel evades the questions, with answers like, "Whey? That could be a way to go." "Salt? Sure. Add it if you'd like." . . . "Yup, you . . . *could* . . . add some molasses . . ."[32]

The last could be a serious contender for the Green Pasture secret "fermentation" recipe because molasses is listed as an ingredient on the label of the Cattle Lick product. Given that this product is manufactured from the spent livers left over from FCLO production, ingredients used for that process that end up in the final product must be included on the label by law. The Green Pasture Cattle Lick label reads as follows:

> ***Ingredients:*** *Sun Dried Cod Liver, Fermented Cod Liver Oil, Salt from Redmond Utah, Clay, Sulfur, Magnesium, Molasses, Organic Iodine, Diatomaceous Earth, Oyster shell.*

Notably, the list also includes salt, as would be expected of any form of fermentation involving brine. Whether the remaining ingredients represent added supplements or residue from the fermenting or filtering processes is unknown. Certainly

food-grade diatomaceous earth can be used for filtering and detoxifying products, but Green Pasture may add it to the Cattle Lick recipe for control of fleas, ticks, worms and other parasites, and/or to detoxify heavy metals. Indeed the diatomaceous earth (rather than the livers and oil) is one likely reason users report lustrous coats on animals that regularly lick the product. Diatomaceous earth also helps reduce manure odor and control flies.[33]

Many companies, of course, keep trade secrets, a policy at odds with the transparency and full disclosure valued by the "real food" community. Unlike Big Pharm and Big Food, most artisanal food manufacturers willingly share at least basic details of their processes with consumers who either want to know what's in their foods or to do it themselves.

CLEAN UP OPERATION

The Green Pasture label for unflavored FCLO lists only one ingredient —"fermented cod liver oil," which suggests he has filtered every last drop of the starter and substrate residue out of the oil. But if so, how? All Wetzel will say is he has "developed a unique cleaning process" that does not rely on carbon filters or heat because those methods "remove flavors, odors, colors and nutrients, and also denature the fragile unsaturated fatty acids such as DHA and EPA." [34]

Whatever else that "unique cleaning process" is doing, the lab data reported in Section II suggests it's *not* protecting EPA, DHA and other fatty acids from rancidity. Indeed, the distinct flavors, odors and colors are indicative of rancidity — extreme rancidity — and that's what the data show. As for nutrient density, lab data reported in Section IV show levels of fat-soluble vitamins that are significantly lower than are to be expected in a cod liver oil. There's a good reason for that, as the report on DNA testing found in Section V will show.

Notably, Green Pasture does not seem to have filed a patent application for its unique and mysterious "fermentation" process.

FERMENTING BY ANOTHER NAME?

If not lacto-fermented, could the liver be "fermented" in some other way? Is it perhaps "pre-digested" as Wetzel sometimes claims? Is it simply the "bacterial/enzymatic digestion of the cell wall to release the lipids from the cellular structure" to use his words?[35] If so, does it happen in dark vats the way digestion oc-

curs in the body where “the sun doesn’t shine”? Then how about that special “solar activation” he likes to talk about?[34]

Is it possible that the liver is “fermented” in the way Eskimos preserve seal or whale blubber? Some FCLO fans think so, especially those who subscribe to the idea that “What doesn’t kill us, makes us stronger.” That technique involves burying foods until they begin to putrefy. Endogenous enzymes in the fat or muscle and/or exogenous enzymes from fungi do the work of breaking down the fat. Problem is, it’s playing Russian roulette with botulism. *C. botulinum* spores are common in fish and mammals from cold climates, and the state of Alaska has the highest incidence of this sometimes fatal form of food poisoning in the United States.[36,37]

Similarly, food historians provide many accounts of fermenting meat and fat in the earth until they become “high.” These include cod’s heads in the Faroe Islands, shark meat in Iceland, venison in Slovakia, and so forth.[38]

FCLO proponents like to point to a photo of hanging shark livers posted on the Weston A. Price Foundation website.[39] This old-fashioned black-and-white photo seems to give the impression that the healthy South Sea Islanders visited by Dr. Weston A. Price enjoyed optimum health because they regularly consumed an oil from “fermented” shark livers. In fact, Dr. Price had nothing to say about this in *Nutrition and Physical Degeneration* or in any of his letters or articles either, according to Joan Grinzi, Executive Director of the Price-Pottenger Nutrition Foundation.[40] Grinzi adds that Dr. Price referred to “fermentation” only twice in his book, and it applied to poi and wine. (For more about what Dr. Price had to say about cod liver oil, see Section VI.)

The shark liver story actually comes from David Wetzel and the photo does not come from Dr. Price. While people in the South Sea Islands probably harvested oil from hanging shark livers, the correct word for the process would not be “fermentation” but “solar rendering.” Moreover, it would have occurred over a few days at most, not over a period of months. In a warm climate, the decay — that Wetzel prefers to call “fermentation” — would have quickly turned to full-on rot. However, the fresh shark oils rendered in this manner would have enjoyed short-term protection from rancidity because of the relatively high levels of the antioxidant Vitamin E naturally found in the shark liver.[41,42] In contrast, cod and most other fish livers are low in Vitamin E.This is the reason that most fish and cod liver oil manufacturers add Vitamin E or other antioxidants to their products.

GOING UNDER

A theory proposed by Alison Birks, MS,[43,44] a nutritionist and herbalist based in Woodbury, CT, and repeated by Kim Schuette, CN, founder of Biodynamic Wellness in Solana Beach, CA, and a member of the Board of Directors of the Weston A. Price Foundation,,[45] holds that FCLO might be produced by "submerged fermentation." Neither defines the actual process beyond stating that the livers are "submerged" in brine for a prolonged period and that the glycogen in the livers provides the substrate needed for fermentation.

This doesn't sound much different from the submersion used in lactic acid fermentation, as when cabbage is kept below the brine for sauerkraut production. As for that glycogen in the livers, there's far too little sugar in there to allow fermentation to proceed. Breakdown of the protein and fats occurs, of course, but through "all natural" putrefaction and rancidification processes that offer few possible benefits and many proven risks. Birks' belief that FCLO is fermented — and the corollary that fermentation can only result in beneficial substances — leads her to repeat Wetzel's oft-heard claims of heightened nutritional value, increased digestibility, lowered toxicity and no added synthetic antioxidants. (In fact, lab testing of FCLO shows little, if any, of this is true, as will be established in Sections III, IV and V.)

True "submerged fermentation" is a high-tech industrial process that fits few of the known facts about Green Pasture's operation. It is widely used by food, supplement and pharmaceutical companies to manufacture antibiotics, enzymes, antioxidants, citric acid, lactic acid, glycerol, hypocholesterolemics, antihypertensives, anti-tumor agents, biosurfactants, and other substances. The process involves feeding corn syrup, cane molasses, beet molasses, malt alcohol or other sugars to bacteria, fungi, and/or other micro-organisms which manufacture the desired enzymes or other products. Unlike lactic acid fermentation, which is anaerobic, the submerged fermentation process is aerobic. It involves aeration through constant stirring and vigorous mixing, and is sometimes completed with injections of pure oxygen. The time table? A mere 18 to 24 hours.[46-48]

GREAT GREEN HOPE?

One last possibility is that Green Pasture could be "fermenting" with the help of algae. Although most algae thrive in the sun, they can be grown in the dark on sugars in a process known as "heterotrophic" fermentation.[49] The algae convert the sugars to oil and biomass, which can be converted, in turn, into biofuels, chemicals, cosmetics and nutritional products including "healthy oils" that many

perceive as more sustainable alternatives to fish oils. Because of the growing interest in biofuel, algae farming is common in Wetzel's state of Nebraska and a leading company based in Omaha is BioProcessAlgae.

Algae are ergosterol-containing organisms that can produce ergocalciferol (Vitamin D2) if exposed to light. This seems like it *could* explain the odd claim of high levels of D2 in the Green Pasture product. But even the most prolific algae would be unlikely to provide such a prodigious boost and even algae have higher levels of Vitamin D3 than D2.[50,51] In any case, as will be discussed in Section IV, only one laboratory found high levels of Vitamin D2 in FCLO and its testing methods appear dubious. Finally, algae could conceivably be enlisted to boost the long-chain DHA fatty acid levels to those found in a true North Atlantic cod liver oil, but whether Green Pasture has ever attempted that is unknown. What's clear is the DHA (docosahexaenoic acid) levels of FCLO consistently test lower than the EPA (eicosapentaenoic acid) levels, the importance of which will be discussed in Section V.

MAKE IT SO!

Is there any other way fish livers could be fermented? Wetzel admits experts in the areas of food science, microbiology, nutrition and fermentation are at loss to explain how his product can be fermented, yet he insists that he knows better. FCLO, he insists, is fermented. He *knows* it's fermented. It *must* be fermented. Or predigested, enzymatically altered, transmuted or transmogrified by some magical process that offers a unique form of rancidity that befits a sacred food — a form no laboratory has identified but that is all benefits and no risks.

* * * * *

ENDNOTES

1. Green Pasture, Singapore. http://bit.ly/1JqY5y3
2. Radiant Life Catalog, http://bit.ly/1K5WtII
3. Perfect Supplements. http://bit.ly/1TVbHB8

4. Author's conversations with David Wetzel at national and regional Wise Traditions conferences and at the airport in Chattanooga, Tennessee.

5. Why we do not add anti-oxidants/rosemary oil . . . preservatives. Green Pasture website. http://bit.ly/1JqYoJ1

6. Shephard, Sue. *Pickled, Potted and Canned: How the Art and Science of Food Preserving Changed the World* (Simon and Schuster, 2000). pp. 124-141.

7. Katz, Sander. *Wild Fermentation: The Flavor, Nutrition and Craft of Live-Culture Foods* (Chelsea Green, 2003).

8. Wild Fermentation, Public Group, Facebook. http://on.fb.me/1LjgQ3M

9. McGruther, Jenny. "Fermented Food: Benefits of Lactic Acid Fermentation." Nourished Kitchen website. http://bit.ly/1USYb3j

10. Sisson, Mark. "The Definitive Guide to Fermented Foods." Mark's Daily Apple website. http://bit.ly/1WESmIP

11. Florou-Paneri P, Efterpi C, Bonos E. "Lactic Acid Bacteria as a Source of Functional Ingredients." http://bit.ly/1E3L8Ij

12. Rahman, M. Shafiur ed. *Handbook of Food Preservation,* (CRC Press, 2nd ed., 2007) pp. 158 and 296.

13. Todar, Kenneth. "Lactic Acid bacteria." *Todar's Online Textbook of Bacteriology.* http://bit.ly/1NBiVbD

14. Curtis, Robert I. Umami and the foods of classical antiquity. *Am J Clin Nutr,* 2009, 90, 3 712S-718S.

15. Pepin, Lisa. "How Fish Sauce is Made: A Visit with a Fish Sauce Maker in Sa Chau, Vietnam." The Kitchn blog. http://bit.ly/1PhJfbt

16. Prichep, Dina. "Fish Sauce: An Ancient Roman Condiment Rises Again." NPR, October 16, 2013. http://n.pr/1DYCniC

17. NTU Food, National Food Institute, Technical University of Denmark. http://bit.ly/1hIephp

18. Nutritional Information, Diet Info and Calories in Cod Liver, Canned. Fitbit. http://bit.ly/1Ey7XP8

19. http://www.greenpasture.org/public/FAQ/index.cfm#1

20. Love, Sandrine. "Celebrating Dave Wetzel and Fermented Cod Liver Oil." April 11, 2012. Nourishing Our Children blog. http://bit.ly/1hjqtpA Also comment by Love at

the Nourished Kitchen website. ". . . the livers are fermented. Most definitely fermented. The livers are fermented to extract the oils. The product could accurately be called 'the oil of fermented cod livers' but, that is a long sentence, and David Wetzel chose fermented cod liver oil instead." http://bit.ly/1fp6l3t

21. Fleming HP, McFeeters RF, Sanders DC. Storage stability of vegetables fermented with pH control. *J Food Sci*. 1983, 48, 3 975-981. http://bit.ly/1PvTNnO

22. Beecher, Cookson. "Fermenting Veggies at Home: Follow Food Safety ABCs." March 11, 2014. *Food Safety News.* http://bit.ly/1IYXG0c

23. Lim, Daniel V. *Microbiology* (McGraw Hill, 2003) p. 184.

24. Todar, Kenneth. "Lactic acid bacteria: *Todar's Online Textbook of Bacteriology.* http://bit.ly/1Mu7aoE

25. Pérez-Diaz, IM, Breidt, F, et al. Chapter 51. "Fermented and Acidified Vegetables," September 2013 http://bit.ly/1PhIP4Q

26. Biello, David. "How Microbes Helped Clean BP's Oil Spill," *Scientific American*, April 28, 2015. http://bit.ly/1K2mSXX

27. Alcaligenes bacteria can contribute to a rise in free fatty acid levels in fish oils during storage. This not generally considered pathogenic. de Koning AJ. The free fatty acid content of fish oil, part V. The effect of microbial contamination on the increase in free fatty acid content of fish oils during storage at 25°C. *European Journal of Lipid Science and Technology,* 1999, 101, 5, 184-186.

28. email from David Wetzel, 10/14/14.

29. Leroy F, De Vuyst L. Lactic acid bacteria as functional starter cultures for the food fermentation industry. *Trends Food Sci. 2004,* 15, 2, 67-78 http://bit.ly/1PhIJtV

30. Boyd, Tim. Concerns about Cod Liver Oil, Weston A. Price Foundation website, February 23, 2015. http://bit.ly/1USYwTz

31. Do you solar activate your oils as Dr. Price did early in the 20th century? FAQ Green Pasture website. http://bit.ly/1fp6tA3

32. Author's conversations with researchers, writers, bloggers and homemakers who have talked with David Wetzel about fermentation.

33. Nature's Wisdom Food Grade Diatomaceous Earth http://bit.ly/1MxWbe0

34. FAQ Green Pasture website. http://bit.ly/1fp6tA3

35. FAQ Green Pasture website http://bit.ly/1fp6tA3

36. Kreston, Rebecca. This Ain't Your Momma's Muktuk: Fermented Seal Flipper, Botulism, Being Cold and Other Joys of Arctic Living *Discover.* Aug 14, 2011. http://bit.ly/1E0SoV9

37. Sobel J, Lynn T, et al. Botulism Type E Outbreak Associated with Eating a Beached Whale, Alaska. *Emerg Infect Dis.* 2004 Sep; 10(9): 1685–1687 http://1.usa.gov/1Ey3FY2

38. Shephard, Sue. *Pickled, Potted and Canned: How the Art and Science of Food Preserving Changed the World* (Simon & Schuster 2000) pp. 131-132

39. http://bit.ly/1LgGJl1

40. Author's conversation with Joan Grinzi, Executive Director of the Price-Pottenger Nutrition Foundation, at PaleoF(x), Austin, TX, April 25, 2015. email from Joan Grinzi April 16, 2015

41. Nichols, P.D., Bakes, M.J., Elliott, N.G. 1998. Oils rich in docosachexaenoic acid in livers of sharks from temperate Australian waters. *Marine and Freshwater Research* 49, 763–767

42. Wu, TH, Stine JJ, Bechtel PJ. Preliminary chemical and nutritional characterization of liver from longnose skates (Raja rhina) *Journal of Food Composition and Analysis,* 2011, 24, 3, 356-361.

43. Birks, Alison. "Fermented Cod Liver Oil: A Traditional Food" http://bit.ly/1K5WtII

44. Safety of Cod Liver Oil. http://bit.ly/1LjhluE

45. Comment by Kim Schuette at the Nourished Kitchen website. http://bit.ly/1fp6l3t

46. Martin, SM. Citric acid production by submerged fermentation. *Ind. Eng. Chem.* 1957, 49, 8 1231–1232.

47. Stanbury PF, Whitaker A, Hall SJ. *Principles of Fermentation Technology.* (Oxford Butterworth Heinemann, 2nd edition, 1995). http://bit.ly/1IYSZDJ

48. Ravichandran S and Vimala R. Solid state and submerged fermentation for the production of bioactive substances: a comparative study. *Int J Sci Nature*, 2012, 3, 3, 480486. http://bit.ly/1gRarlW

49. Algae Basics: Fermentation. All about Algae. http://bit.ly/1NEYcUr

50. Björn LO, Wang T. Is provitamin D a UV-B receptor in plants? *Plant Ecology,* 2001, 154, 1-2, 1-8.

51. Rao DS, Raghuramulu N. Food chain as origin of vitamin D in fish. *Comp Biochem Physiol* 1996, 114A, 1, 15-19.

SECTION II: STINKIN' THINKIN'

It's brown, it stinks and it can burn people's throats.

Common sense says this product's rancid. But common sense seems to be in short supply these days, and it seems especially rare among health-conscious people who've come to believe that if a food tastes bad then it must be good for us, and if smells bad too, it might be even better. According to this line of thinking, people hooked on FCLO think it must be nothing less than the power food of the ages.

Then again, it might just taste nasty because it's rotten.

Proving it is rancid, however, proved surprisingly challenging.

Laboratories used by the fish oil and vegetable oils industry are set up to test products for early stages of rancidity. They serve supplement manufacturers who have designed
elaborate safeguards to protect fragile oils from rancidity due to air, light, heat or other factors.[1] Fish and fish liver oils with the long-chain fatty acids EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) have a lot of fragile oils to protect.

Yet Green Pasture purposely allows its livers to "ferment" for months. Although Wetzel keeps the details of his processing methods shrouded in myth and mystery, there's little doubt that there is high potential for rancidity. Fragile polyunsaturated oils, after all, do not thrive under changing "all natural" conditions of heat, light and air, all of which could be present if Wetzel is, as he sometimes says, "solar activating" his product.[2] Most likely, he is producing FCLO in opaque vats under airtight anaerobic conditions. That's the word of Tim Boyd at the Weston A. Price Foundation[3] and what many photographs suggest.[4] In that case, he might have light and air under control, but probably not temperature. Wetzel says he does not "heat" his product, but anyone who's had a sun room or greenhouse knows that "solar facilities" during the summer can reach scorching hot levels.

Despite the risks of long-term processing and the apparent lack of controls, Green Pasture reports that it regularly orders lab testing and can prove FCLO is not rancid. Indeed, the Green Pasture website reports seemingly acceptable levels of rancidity markers such as peroxide, anisidine and TBA.[5] Samples sent to the same lab (Lab #4) as part of this investigation yielded similar data, suggesting that Green Pasture did not achieve non-rancid results by fraudulently submitting cleaner-than-usual samples or cod liver oil from his competitors.

Does this prove FCLO is not rancid? No. Because it's the wrong kind of testing for a long-term "fermented" product. Evaluating rancidity in oils is like taking aim at a moving target. Tests used to evaluate rancidity provide data that will be a "hit or a miss" depending on where the oil is in its life cycle. An oil that's rancid before it's even bottled is likely to test "negative" on all primary and most secondary signs of rancidity. Fatty acid levels and Acid Value, on the other hand, increase along with rancidity over the lifetime of the oil.[6-9] They are by far the most reliable markers for the Green Pasture product. And they are troubling numbers indeed.

Let's look more closely at the different lab tests and data:

PEROXIDE VALUE

Peroxide value (PV) measures the levels of lipid peroxides. PV increases during the early life of oils, and decreases in the more advanced stages. High peroxide values always indicate a rancid fat, but moderate or low values prove little or nothing. The PV value of FCLO as found at Lab #2 came in at 0.2 meq/kg. Lab #5 found 0.53 meq/kg. Lab #7 found 2.42 meq/kg. Lab #4 showed "non-detectable."

These levels are extremely low — and are even lower than the results of 3.9 meq/kg and 4.0 meq/kg that Green Pasture reports on its website. The FAO (Food and Agriculture Organization of the United Nations) standard for fish oils and fish liver oils is that Peroxide Value be less than or equal 6 meq/kg.[10] The quality standard set by the Global Organization for EPA and DHA (GOED)[11] is 5 meq/kg and by the Council for Responsible Nutrition (CRN)[12] is 6 meq/kg.

These low results are hardly surprising given that FCLO has been "fermenting" for months, with its peroxides long since decomposed into secondary and tertiary oxidation products. Very rancid oils have low Peroxide Values. Most fish and fish liver oils sold in the marketplace show peroxide values that start low, increase, peak, and then decrease over the storage life of the oil. Manufacturers try to extend the "lag phase" before oxidation takes off as long as possible by lowering temperature, reducing oxygen and adding antioxidants. In contrast, FCLO has gone through its entire peroxide cycle from low to high and back to low before it is even bottled.

In a video posted on the Green Pasture website,[13] Wetzel states that he has found extremely high peroxide values of 15 to 40 meq/kg at the peak of the peroxide bell curve but that the levels drop to 0 to 5 meq/kg by the time he bottles

his product. Does this mean rancidity has disappeared and is no longer cause for concern? Many viewers might think so. But, no. Rancidity is still present but has progressed to a more advanced stage.

In all probability, FCLO is bottled at the point that it has become so rancid that it can't get much worse. Indeed, this is the likely reason FCLO seems to have "shelf stability" compared to other oils and why antioxidants won't help. Extreme rancidity is also why some loyal consumers report its flavor to be "strong," "disagreeable" or "objectionable," yet insist it is not "rancid." To them, rancidity is a distinct smell-and-flavor characteristic associated with a food or an oil that has recently "turned" or "gone bad" and which, if tested, would show a moderate to high Peroxide Value with a rising Anisidine Value.

ANISIDINE VALUE

Anisidine Value (p-AnV) is a marker of secondary oxidation that helps tell the history of an oil. Typically peroxide levels will rise over the first couple weeks or months as an oil starts to turn rancid, then drop off as the peroxides isomerize into aldehydes, ketones and other secondary oxidation products. At this point, anisidine values begin to climb, flavors and odors become objectionable, and consumers may experience burping. Next, anisidine levels, in turn, will decrease.[14,15] Three labs testing FCLO's anisidine level reported seemingly acceptable levels. Lab #2 found 6.8, Lab #4 reported 13, and Lab #7 found 3.44. On its website Green Pasture reported test results at 9 and 16.

Lab #5 tried to test for anisidine value, but failed because of a mysterious compound in the sample that "caused interference with the method." Other testers too have run into that problem, with most concluding that interference came from the "brown pigment" or blood.[16] Although blood could be part of the protein residue from fermenting fish livers, Lab #2 showed very low levels of iron. At less than 0.0002 percent, it's highly unlikely that the brown color comes from blood.

The Food and Agriculture Organization of the United Nations (FAO),[17] Council for Responsible Nutrition (CRN)[18] and Global Organization for EPA and DHA (GOED)[19] suggest fish oils and fish liver oils meet a quality standard in which Anisidine Value is less than or equal to 20. While low anisidine numbers might suggest non-rancidity for FCLO, it's important to remember that Anisidine Value — like Peroxide Value — is a poor marker of rancidity in an oil that's been "fermenting" for months.

TOTOX VALUE

TOTOX (TOTal OXidation) Value is a level calculated with PV and p-AnV data. The formula is (2 x PV) + p-AnV= TOTOX. TOTOX is a valuable tool for evaluating commercially produced oils as it reveals a quality problem for any oil marked with both a high Peroxide Value and Anisidine Value. In general,"The lower the TOTOX, the better the quality of the oil."[20,21]

The TOTOX Value for FCLO — as calculated from PV and pAnV levels from Lab #2 is 7.2 meq/kg and from Lab #4 is 13 meq/kg. Lab #7 reported a TOTOX level of 8.27 meq/kg.

On the face of it, the TOTOX values for FCLO look good. They are not only well under the FAO, CRN and GOED cut off of 26 meq/kg[22-24] but under 19.5 meq/kg, which is the higher Fish Oil Industries standard that marks the point at which an oil is likely to turn rancid.[25] Unfortunately, TOTOX Value depends on PV and p-AnV, and so is useless for evaluating a product that's already been "fermenting" for six months to a year.

TBA (THIOBARBITURIC ACID)

The TBA test was developed to detect malondialdehyde (MDA), a byproduct of polyunsaturated oil breakdown that reacts with DNA, inducing genotoxicity and chromosomal aberrations. MDA has been linked to many serious and potentially fatal health problems, including pulmonary embolism, heart disease, connective tissue disorders, and cancer.[26- 36]
Given the well-established dangers of MDA to human health, TBA readings would seem desirable. Unfortunately, simple measurements of MDA aren't worth much. The problem is MDA levels decrease whenever MDA reacts with proteins, DNA or phospholipids to form other toxic substances. If the TBA test occurs early in an oil's life cycle, the aldehydes may not have yet formed, but if the test occurs late in the game, the aldehydes may have reacted with protein or other components in the sample or simply volatilized.[37-39] Thus, TBA, too, tells only part of the story.

Lab #2 reported a TBA Value of 0.20 and Lab #4 reported 0.28. Green Pasture has reported 0.55, 0.49 and 1.59 on its website. These numbers are all low, but, as already discussed, could be the erroneous result of malondialdehyde reacting with proteins under conditions of oxidation. On the other hand, a TBARS (Thio-Barbituric Acid Reactive Substances) test at Lab #7 came up with a result of

23.60 mg/kg, which is high. Standard Process Laboratory reported “MDA, an indicator of polyunsaturated fatty acid oxidation, was 10-fold higher in the fermented product” compared to the other cod liver oil samples.[40] These results vary greatly. Given that FCLO naturally contains some protein residue from “fermenting” livers, TBA would appear to be an unreliable way to test FCLO for rancidity.

FREE FATTY ACIDS

Virtually all fats and oils in the plant and animal kingdoms start out in the triglyceride form, in which three free fatty acids are attached to a glycerol backbone. As the oils start to go rancid, the fatty acids begin to break free in a process called “lipid hydrolysis.” The percentage of TAGs (triacylglycerols, the term for the most prevalent form of triglycerides) then decreases and the percentages of DAGS (diacylglycerols) and MAGs (monoacylglycerols) increase.[40,41]

Oils from fresh livers will be light colored with a high triglyceride level and low free fatty acid content while oil obtained from livers which have begun to decompose will be darker in color with a lower triglyceride and higher free fatty acid content. Light-colored oils were traditionally considered “medicinal”; darker oils were for animal feeding and the darkest were used for paint, varnish and other industrial applications.[42,43]

Many stressors can increase the Free Fatty Acid content of oils, including the manufacturing process; duration and conditions of storage; and the nature of the fatty acids themselves. The last will vary from species to species — for example, pollock will differ from cod — and within a species according to the fish’s age, climate, season, environment, and other factors.[44,45]

According to independent marine oils expert Anthony P. Bimbo, the allowable limit of Free Fatty Acids (FFAs) for crude fish oil is in the range of 1 to 7%, but typically at 2 to 5%.[46] The percentage of Free Fatty Acids in FCLO is much higher, as would be expected of a dark-colored oil. Lab #2 reported Free Fatty Acids at 16.2% and Lab #7 found an extremely high level of free fatty acids at 40.10%. Green Pasture’s own test data as posted on its website also came in high at 19.2% and 25.3%.

ACID VALUE

Acid Value quantifies the free fatty acids (FFAs) that have split off from the parent triglycerides though lipid hydrolysis. As oils become rancid, triglycerides break down into fatty acids and glycerol, causing an increase in acid number. Acid Value is 1.99 times the Fatty Acid Value.[47]

Lab #2 reported Free Fatty Acids at 16.2% and Acid Value of 32.3 mg/KOH/g. Lab #4 showed an Acid Value of 27.97 mg/KOH/g. Lab #7 reported an extremely high level of free fatty acids at 40.10% and an Acid Value of 79.8 mg/KOH/g. Green Pasture's Free Fatty Acid test results came in at 19.2% and 25.3% which (multiplied by 1.99) yield Acid Values of 38.2 and 50.3, respectively.

Lab #5 didn't provide numbers, but reported "relatively high" levels of FFAs, DAGs (Diacylglycerols) and MAGs (monoacylglycerols), implying "a significant hydrolysis of the TAGs (triacylglycerols) originally present in the raw material."

Acid Value should be less than or equal to 3 mg KOH/g according to FAO, CRN and GOED standards.[48-50] European Pharmacopoeia Standard (EPS) is more stringent with its maximum of 0.5 mg KOH/g.[51] Green Pasture's products range from an Acid Value of 32.3 mg-KOH/g to a whopping 79.80 mg-KOH/g. In plain English, these Acid Value numbers are extremely high.

So high that they blow any claims that FCLO is a non-rancid oil right out of the water.

PLAYING COD WITH CONSUMER HEALTH

The marine oils experts I talked to all found the FFA and Acid Value numbers to be shockingly high, and several lab managers said FCLO was the most rancid fish liver oil they'd ever tested. They based their opinion on both objective lab data and subjective organoleptic impressions from of smell, taste, texture.[52]

Yet Wetzel insists there is no problem. He argues Free Fatty Acid level is "not an oxidative marker," that high Free Fatty Acid levels in his product are desirable, and that textbooks that disagree with his position need to be revised. In his view, leading researchers and scientists are ignorant and either just don't understand his unique natural product or are biased against it. Indeed, Wetzel thinks the more Free Fatty Acids the merrier because they offer consumers the benefits of "pre-digestion."[53,54] In other words, since triglycerides are going to be metabo-

lized in the body anyway, why not provide readymade rancid products to give the body a head start?

This singular point of view disregards a massive body of research showing that rancid EPA, DHA and other polyunsaturated fats (PUFAs) in the diet can cause, contribute to and accelerate the growth of heart disease, cancer, reproductive disorders and other ills. Free Fatty Acids are so cytotoxic to cell membranes that the body makes it a priority to build them back into the safe triglyceride form as quickly as possible.[55,56] Sadly, far too many consumers of FCLO have fallen for the idea that Wetzel knows more than the world's leading fats and oil scientists, that the laws of science don't apply to traditional foods, and that FCLO offers a unique, sacred and desirable form of rancidity.

* * * * *

ENDNOTES

1. Conversations with managers and technicians at food, supplement and marine oils laboratories. Few are set up to properly test fresh or fermented fish oils because so few manufacturers produce them.

2. Do you solar activate your oils as Dr. Price did early in the 20th century? http://bit.ly/1Jiyup7. In August 2015, subsequent to the publication of the Price-Pottenger Nutrition Foundation's eBook *What Dr. Price Said about Cod Liver Oil,* Wetzel took down his original post and replaced it with: "Our plant is exposed the sun but this does not equate to solar activation as Dr. Price discusses. Dr. Price had a specific protocol and definition for the term solar activation and it does not occur unless uv rays are directly exposed to the products. In our plant the products are not exposed to solar uv."

3. Boyd, Tim. Concerns about cod liver oil. http://bit.ly/1USYwTz

4. Photographs and videos from Wetzel and also from bloggers and others who have visited his facilities.

5. Products Test Data, Green Pasture website. http://bit.ly/1TTLHva

6. Measuring Rancidity in Fats and Oils: What is the best way to measure the quality and stability of fats and oils? N.P. Analytical Laboratories. http://puri.na/1E0TFvc

7. Miller, Matt. Oxidation of Food Grade Oils: Plant and Food Research http://bit.ly/1TPuO50

8. O'Brien, Richard. *Fats and Oils: Formulating and Processing for Applications* (CRC Press, 3rd Ed, 2008). p. 220-222.

9. Albert, BB, Cameron-Smith, D et al. Oxidation of marine omega-3 supplements and human health. *Biomed Res Int,* 2013; 464921 http://1.usa.gov/1gRbimI

10. FAO Joint FAO/WHO Food Standards Programme. Codex Alimentarius Commission. 38th Session, CICG Geneva Switzerland, 6-11 July 2015. Report of the 24th Session of the Codex Committee on Fats and Oils, Melaka, Malaysia. February 9-13, 2015. p. 35

11. GOED, Global Organization for EPA and DHA Omega 3. Voluntary Monograph (v.4) http://www.goedomega3.com/index.php/our-members/quality-standards

12. CRN, Council for Responsible Nutrition, Voluntary Monograph, March 2006 AOCS http://bit.ly/1IZ2cvF

13. Fermented Food Study and Taste Test Video. http://bit.ly/1TPvJm0

14. Miller.

15. O'Brien p. 200

16. Conversations with researchers, scientists and lab technicians.

17. FAO/WHO

18. CRN

19. GOED

20. Miller.

21. FAO/WHO

22. FAO/WHO

23. CRN

24. GOED

25. Fish oil shelf life: How fresh is your fish oil? April 22, 2014. IFOS: The International Fish Oil Standards Program. http://bit.ly/1E1cj6p

26. Botsoglou, NA, Fletouris DJ et al. Rapid, Sensitive and specific Thiobarbituric acid method for measuring lipid peroxidation in animal tissue, food and feedstuff samples. *J Agric Food Chem,* 1994, 42, 1931-1937.

27. Janero DR, Burghardt B. Thiobarbituric acid-reactive malondialdehyde formation during superoxide-dependent, iron-catalyzed lipid peroxidation: influence of peroxidation conditions.*Lipids.* 1989, 24, 2, 125-31.

28. Janero DR. Malondialdehyde and thiobarbituric acid-reactivity as diagnostic indices of lipid peroxidation and peroxidative tissue injury. *Free Radic Biol Med*. 1990, 9, 6, 515-540.

29. Ahmad RI, Tripathi AK et al. Malondialdehyde and protein carbonyl as biomarkers for oxidative stress and disease progression in patients with chronic myeloid leukemia. *In Vivo.* 2008, 22, 4, 525-528.

30 Tanaga KI, Bujo H, et al. Increased circulating malondialdehyde-modified LDL levels in patients with coronary artery diseases and their association with peak sizes of LDL particles. *Arterioscler Thromb Vasc Biol*. 2002, 22, 4, 662-666.

31. Amara AI, Constans J, et al. Autoantibodies to malondialdehyde-modified epitope in connective tissue diseases and vasculitides.*Clin Exp Immunol.* 1995, 101, 2, 233-238.

32 Niedernhofer LJ1, Daniels JS et al. Malondialdehyde, a product of lipid peroxidation, is mutagenic in human cells. *J Biol Chem*. 2003, 278, 33, 31426-31433.
,
33 Rudra CB1, Qiu C, et al. A prospective study of early-pregnancy plasma malondi-aldehyde concentration and risk of preeclampsia. *Clin Biochem*. 2006, 39, 722-726.7
.
34 Meral E, Sekeroglu MR et al. Roles of the Oxidative Stress and ADMA in the Devel-opment of Deep Venous Thrombosis*. Biochem Res Int.* 2014, 2014, 703128.

35 Re G, Lanzarini C et al. Systemically circulating oxidative species in human deep venous thrombosis. *Eur J Emerg Med.* 1998, 5, 1, 9-12.

36. Draper HH, Polensek L, Hadley M, McGirr LG.Urinary malondialdehyde as an indi-cator of lipid peroxidation in the diet and in the tissues. *Lipids.* 1984, 19, 11, 836-843.

37. Damodaran S, Parkin KL, Fenneman OR. *Fennema's Food Chemistry* (CRC Press, 4th ed, 2007) p. 209.

38. Janero DR. Malondialdehyde and thiobarbituric acid-reactivity as diagnostic indices of lipid peroxidation and peroxidative tissue injury. *Free Radic Biol Med.* 1990, 9, 6, 515-540.

39. Colorimetric Microplate Assay for 2-Thiobarbituric Acid Reactive substances. Oxford Biomedical Research. http://bit.ly/1hIcppm

40. Metzger BT, Barnes DM. Nutritional profiling of cod liver oil processed by molecular distillation, fermentation, or unrefined.*FASEB,* 2012, 26, 636. http://bit.ly/1IXs6lx This study was only published as an abstract and Standard Process declined to share the complete study or specific data.

41. O'Brien, 220-221.

42. Holmes, AD, Tripp F, et al. Influence of storage on the fatty acid content of cod liver oil. *J Am Oil Chem Soc,* 1934, 11, 6. http://bit.ly/1NorwAz

43. Cod liver oil: A Historical Perspective. Price Pottenger Nutrition Foundation, August 6, 2015. http://bit.ly/1TTNf8u

44. Bimbo, Anthony P. Guidelines for Characterizing Food Grade Fish Oil. International Fishmeal and Oil Manufacturers Association. 1998, 9, 473-483. http://bit.ly/1E1bgmJ

45. Albert, BB, Cameron-Smith D, et al. Oxidation of Marine Omega-3 Supplements and Human Health *Biomed Res Int.* 2013, 2013, 464921.

46. Bimbo.

47. O'Brien, 220-221

43. FAO/WHO

44. CRN

45. GOED

46. European Pharmacopoeia 8.0. http://bit.ly/1NBnXoF

47. O'Brien, 221.

48. FAO

49. CRN

50. GOED

51. European Pharmacopoeia.

52. Conversations with marine oil scientists, lab managers and others.

53. Numerous postings on the Green Pasture website, including: http://bit.ly/1gRrIeI and http://bit.ly/1IXJSoP

54. Conversations with David Wetzel at Wise Traditions regional and national conferences and at Chattanooga Airport. Email correspondence during October 2014.

55.Damodaran S, Parkin KL, Fenneman OR. *Fennema's Food Chemistry* (CRC Press, 4th ed, 2007) p.159.

56. Shaikh, SR, Edidin M. Polyunsaturated fatty acids, membrane organization, T cells and antigen presentation. *Am J Clin Nutr,* 2006, 84, 6, 1277-1289,

SECTION III: IN BAD TASTE

Biogenic amines are compounds that arise when proteins go bad, bacteria grow wild, food spoils and flesh decomposes. Properly controlled, biogenic amines give us the distinctive odors and flavors of ripe cheeses, high meats, pungent fish sauces, strong sausages and fine wines. Anthony Bourdain has famously written, “To me, life without veal stock, pork fat, sausage, organ meat, demi-glace, or even stinky cheese is a life not worth living.”[1] Unfortunately, increasing numbers of people in the modern world are unable to tolerate these traditional, amine-rich foods.[2-5]

The severity of the symptoms people experience depend on many factors, including the amount, type and variety of amines ingested, bio-individuality and detoxification ability. Ideally, we should be able to tolerate some biogenic amines as they have positive roles to play in hormone and neurotransmitter production and regulation, digestion, cardiovascular health, immune system modulation, and many other brain/body functions.[6]

FOUL PLAY

The best known of the biogenic amines are tyramine, histamine, cadaverine and putrescine. Cadaverine and putrescine, as their names suggest, are associated with the foul smells of putrefying and decaying corpses. But it’s tyramine and histamine that cause the most trouble for people.[7]

Tyramine reactions can cause headaches, migraines, neurological disorders, nausea, vomiting, respiratory disorders, hypertension and other unwanted effects. Histamine reactions can lead to a variety of symptoms, including headaches, sweating, rashes, respiratory distress and speedy heart rate. Worse, other biogenic amines — including putrescine, cadaverine, tyramine, phenylethylamine, spermine and spermidine — can potentiate toxic effects from histamine by inhibiting histamine-metabolizing enzymes in the intestine, increasing histamine uptake and liberating endogenous histamine.[8,9]

Because biogenic amines can cause food poisoning and are unwanted in most processed foods, regulatory agencies require commercial food manufacturers to carefully monitor concentrations throughout the process along with other food safety measures. Their concerns are “food intoxication” and “hygiene.”[10]

OVER A BARREL

Biogenic amines are high in most fish and fish sauce products, but they are not typically found in fish oils or cod liver oils. They may be present in FCLO, however, because Green Pasture's production method involves the "fermenting" of fish livers for many months. Wetzel likens his method to the traditional process of fishermen tossing fish livers in a barrel,[12] but it is important to note that the historical accounts speak of "putrefaction" of the livers that occurred in the days, weeks and months ahead. And contrary to the Green Pasture myth, the brown oils were not considered optimal. Nearly all the historical accounts say the pale, golden and light brown cod-liver oils harvested early on the process were valued for medicinal purposes. Medium brown cod-liver oils were used in a pinch, but the dark brown oils were rarely if ever consumed. Rather they were preferred for lamp oil, paint, varnish and other industrial purposes. Indeed, dark brown cod-liver oils were so cheap that the poor painted their buildings red with a mixture of iron oxide and brown cod liver oil.[13-16]

SPOILER ALERT

"Fermenting" cod livers — or "putrefying" them, to use the word preferred by historians— is highly likely to result in biogenic amines. As the hepatic cells in the livers break down, they not only release oil but also blood and other protein residues. Even if the glycogen in the liver or any added carbohydrates "ferment," the oil released will start to go rancid while the protein will begin to putrefy. Without an effective filtering system, some of that decomposing protein residue — blood and biogenic amines — is likely to end up in the final product.

Green Pasture insists few biogenic amines get into FCLO. But just in case they do, Wetzel reminds us of the abundance of tyramine, histamine and other biogenic amines found in cheeses and other healthy traditional foods. Tyramine. he says "is a common amine in fish and is the common amine in cheese" and is also what gives FCLO its strong flavor. Tyramine, he says, is "typically derived through different protein digestion by Lactobacillus family of bacteria. Most in our community understand this as good and proper."[17]

As discussed in Section I, Wetzel's "fermentation" method may not be "good and proper" at all. As established in Section II, the method results in rancid oils. Yet, the Green Pasture website[18] reports non-detectable (ND) levels for most of the biogenic amines tested and moderate levels for a few:

- Phenylethylamine 18 ppm, 13 ppm and 9.8 ppm.
- Tyramine 14 ppm, 5.3 ppm and 4.8 ppm.
- Spermidine 3.1 ppm, 2.9 ppm or non-detectable (ND)
- Tryptamine 4.3 ppm or ND
- Spermine 4.2 ppm or ND

Samples sent to the same lab — Lab #4 — as part of this investigation showed non- detectable levels for all eight biogenic amines tested, suggesting that Green Pasture did not achieve low levels of biogenic amines by fraudulently submitting cleaner-than-usual samples or a processed cod liver oil from his competitors.

However, in his Frequently Asked Questions section, he reveals tyramine levels for FCLO range from 5 to 50 ppm.[19]

Samples sent to Lab #2 showed a presence for biogenic amines, with none at high levels.

- Phenylethylamine 10.3 mg/kg
- Spermine < 1 mg/kg
- Cadaverine 2.52 mg/kg
- Histamine 2.26 mg/kg
- Putrescine <1mg/kg
- Spermidine <1 mg/kg
- Tryptamine 7.61 mg/kg
- Tyramine 8.81 mg/kg

In contrast, data from Lab #7 showed extremely high levels of tyramine, tryptamine, putrescine, phenyletylamine and cadaverine. These levels would almost certainly cause tyramine-sensitive people to react — and perhaps severely. Those on monoamine oxidase inhibitors (MAOI) medications would be at special risk.[19] Notably the histamine level is extremely low.

- Tryptamine 113 mg/kg
- Phenylethylamine 168 mg/kg
- Putrescine 44.3 mg/kg
- Cadaverine 85.5 mg/kg
- Tyramine 177 mg/kg
- Histamine <10 mg/kg
- Tyramine 177 mg/kg
- Spermidine <10 mg/kg
- Spermine less than <10 mg/kg

Why the data from Lab #4 and Lab #2 came in at non-detectable or low to moderate while Lab #7 tested high for many biogenic amines is a mystery. The fact that Lab #4 offers biogenic amine testing only in the pet food category might raise eyebrows. But all the labs use the same cut off point of parts per million.

The FCLO samples I submitted this spring for testing at Labs #2 and #4 were manufactured in late 2013 or early 2014. The testing at Lab #7, however, occurred back in August 2013 and involved submission of a FCLO sample from 2012. As will be discussed in Section V, Green Pasture *may* have evolved its manufacturing method since 2012 to produce a cleaner product. Given that the recent samples of FCLO are far less likely to cause tyramine reactions in sensitive individuals, this might be good news. Then or now, histamine reactions seem not to be a problem.

* * * * *

ENDNOTES

1. Bourdain, Anthony. *Kitchen Confidential: Adventures in the Culinary Underbelly.* (Bloomsbury, revised edition, May 2013). p. 78.

2. Naila A, Flint S et al. Control of biogenic amines in food — existing and emerging approaches. *J Food Sci*, 2010 75, 7, R 139-R150. http://1.usa.gov/1JriWBk

3. Ladero V, Calles M et al. Toxicological effects of dietary biogenic amines, Instituto de Productos Lácteos de Asturias, Asturias,. Spain. http://bit.ly/1PhQos2

4. Joint FAO/WHO Expert Meeting on the Public Health Risks of Histamine and Other Biogenic Amines from Fish and Fish Products. 23-27 July, 2012. FAO Headquarters, Rome, Italy. http://bit.ly/1J4PT0Y

5. EFSA Panel on Biological Hazards (BIOHAZ) , *EFSA Journal*, 2011, 9, 10, 2393

6. Ladero, Calles.

7. EFSA Panel on Biological Hazards (BIOHAZ) , *EFSA Journal*, 2011;9(10):2393

8. Ladero, Calles.

9. Joint FAO/WHO

10. EFSA

11. Joint FAO/WHO

12. Wetzel, David. How our most important dietary supplement is produced. March 1, 2006. Weston A. Price Foundation website. http://bit.ly/1WF6Gkl

13. Cod liver oil: a historical perspective. Price-Pottenger Nutrition Foundation, August 6, 2015. http://bit.ly/1TTNf8u

14. Bennett, John Hughes. *Treatise on the Oleum Jecoris Aselli or Cod Liver Oil. (*Scholar's Choice, 2015). Reproduction of 1841 original.

15. Möller, Frantz Peckel. *Cod-Liver Oil and Chemistry* (Nabu, 2010). Copy of 1895 original.

16. Why are Norwegian houses painted red? http://bit.ly/1JcMrAm

17. Are amines as scary as some bloggers would have you believe or natural and abundant? FAQ - Frequently Asked Questions. Green Pasture website. http://bit.ly/1Jiyup7

18. Test Data, Green Pasture website. http://bit.ly/1WF6HVx

19. Are amines as scary as some bloggers would have you believe or natural and abundant? FAQ - Frequently Asked Questions. http://bit.ly/1Jiyup7

20. Hall-Flavin, Daniel K. I just started taking MAOIs for depression. Do I really need to follow a low-tyramine diet? *Mayo Clinic Patient Care & Health Info*. http://mayocl.in/1NeiFCv

SECTION IV: NETTING A, D, E and K

Green Pasture and the Weston A. Price Foundation (WAPF) report that the levels of Vitamins A and D in fermented cod liver oil (FCLO) are extraordinarily high — at least double the amounts found in other cod liver oils. Supposedly a single teaspoon can provide levels of Vitamin A levels at approximately 9,500 IU per teaspoon, with vitamin D levels at 1,950 IU.[1]

Curiously, WAPF and Wetzel insist the Vitamin D in FCLO is mostly made up of Vitamin D2 — not the inferior D2 obtained from irradiated yeast, but a unique and sacred form of D2 first identified by them in Green Pasture fermented cod liver oil.[2,3]The fact that none of the world's leading marine oil scientists has recognized this unexpected find has not fazed their promotion of it.[4]

In fact, Green Pasture's high fat-soluble vitamin theory makes little sense to people outside the world of FCLO. While fermentation can increase vitamin content — particularly the level of B vitamins[5] — it's a leap of faith to think the process could boost Vitamin A to a whopping 9,500 IU or even more. Vitamin A is set at 4,500 IU per teaspoon for a standardized cod liver oil and found at anywhere from 3000 to 6000 IU per teaspoon in a natural cod liver oil. Similarly, we find Vitamin D guaranteed at 450 to 500 IU in standardized products and typically found at 400 to 500 in a natural product.

As for most of FCLO's Vitamin D showing up as Vitamin D2, that's a very strange finding indeed.

THE NUMBERS GAME

As reported by Lab #2, the level of Vitamin A found in FCLO is not too shabby at all. It is typical of any natural cod liver oil, but well under the 9,500 IU promised on the Weston A. Price website and the rounded-off 10,000 IU figure that is frequently lobbed around the internet. Lab #2 shows Vitamin A at 73,200 IU per 100 grams (3,147.6 IU per tsp).

The labs furthermore report that most of the Vitamin D is in the expected D3 form, with minuscule levels of D2. The total Vitamin D, however, is strikingly low

— well under what would be expected of a natural cod liver oil. Lab #1 shows Vitamin D3 at 17.6 IU per gram (75.7 IU per tsp) and Vitamin D2 at less than 0.04 IU per gram (under 0.172 IU per tsp).

Lab #1 found nearly non-existent levels of D2. In contrast, the Green Pasture website records data on more than 60 samples tested between 2008 and 2013. Not all the reports separate out the D3 and D2, but whenever both are reported, the D2 levels dwarf the D3. A few examples of lows and highs from 2013 are listed below (with a rough calculation from milliliters to grams at 0.9 grams per milliliter and 4.3 grams per teaspoon).

For the year 2013, Green Pasture reported the lowest and highest levels of Vitamin A at:

- March 29, 2013: 35 IU/mL retinol and 310 IU/mL palmitate (135.5 and 1199.7 IU per tsp)
- April 9, 2013: 220 IU/mL retinol and 3250 IU /mL palmitate (851.4 and 12,577.5 IU per tsp)

In 2012 Green Pasture reported the low and high Vitamin for D2 (plus the accompanying D3) as:

- May 18, 2012: 810 IUs/ML D2 with 100 IU/mL D3 (3134.7 IU of D2 and 387 IU D3 per tsp)
- June 28, 2011: 2971 IUs/mL D2 with 53 IUs/mL D3 (11,497.8 IU of D2 and 2055 IU D3 per teaspoon)

Wetzel attributes so much variation to his product being “all natural” and the vagaries of the fermentation process.[6,7] Skeptics say the data make no sense.

LAB IN THE HEADLIGHTS

The incongruous data cited by Green Pasture and the Weston A. Price Foundation come from one small laboratory, UBE Analytical Laboratories of Fullerton, California, which uses HPLC (High Performance Liquid Chromatography), a technique that involves ultra-violet light detection. UBE’s Lab Manager Danny Pang prides himself on unique testing methods, the specifics of which he has declined to disclose, and which have produced results that no one else seems to have replicated.[8] While Pang may yet prove to be a genius who has gone boldly

where no lab has gone before, the likelier explanation is inappropriate testing methods and/or erroneous analysis.

As W. Craig Byrdwell, Research Chemist at the USDA Food Composition and Methods Development Lab in Beltsville, MD, and author of numerous publications in peer-reviewed journals, puts it: “If the method is UV detection, it is very easy to be fooled. There are numerous other lipid-soluble components that overlap with the retention times of both Vitamin D2 and Vitamin D3.”[9]

As Byrdwell explains in the August 2008 issue of the *American Journal of Clinical Nutrition,* “Historically, the measurement of vitamin D concentrations in foods has presented an enormous analytic challenge. Vitamin D is a complex, highly reactive and lipophilic molecule. Extracting vitamin D from food materials with all the other lipid components complicates an already difficult separation process and makes detecting vitamin D by ultraviolet molecular absorption highly problematic.”[10]

Unlike UBE Analytical Laboratories, credible and consistent results from major laboratories specializing in marine oil testing show minuscule amounts of Vitamin D2 in all cod liver oils tested including FCLO. Michael F. Holick, PhD, MD, professor of medicine, physiology, and biophysics at Boston University Medical Center and the world’s leading Vitamin D researcher, said in 2013 that he had never found D2 in cod liver oil.[11] Furthermore, many laboratories including the Institute of Aquaculture, Stirling University in Scotland, have tested fish livers and many unrefined/unprocessed fish liver oils over many years without ever finding more than minimal amounts of D2.[12]

Could all these experts be wrong? Wetzel and Fallon-Morell think so, saying that the D2 has gone missing because the labs lack UBE’s unique technology. As for the researchers, Wetzel blames their failure to “seek and find” the elusive D2 on lack of curiosity, limited intelligence, lackluster initiative, investment in the status quo and “kick backs” from the Vitamin D3 supplement industry.[13]

Is there any way D2 could be present at high levels in a fish liver oil? It sounds like a possibility worth exploring. Pro-Vitamin D, D2 and D3, after all, can all be found in the plankton that fish eat.[14,15] That may be so, but D2 in the food doesn’t guarantee D2 in the fish. Is this because Vitamin D3 is the form most bioavailable to fish? Do fish preferentially incorporate D3 into their cells, tissues and organs and excrete most of the D2? Can fish convert D2 into D3? Whatever the case, the evidence to date is that D2 is not getting into fish liver oils.

GREEN PIGMENT OF THE IMAGINATION

Could the “fermentation” process produce D2? Yes, if Green Pasture is growing ergosterol-containing organisms such as algae in a sea-water brine and employing UV light to convert the ergosterol to ergocalciferol (Vitamin D2). The fact that some algae can be cultured anaerobically and create their own ecosystems suggests fermentation might be possible. The algae’s work would then have to be followed up with light activation, which could be the “solar activation” Wetzel claims to be part of his secret processing method.[16-18] While this is an intriguing possibility, it’s questionable whether the algae could significantly boost the vitamin D2 levels in his oil. Even more importantly, this does not explain the extremely low D3 levels reported by UBE Analytical Laboratories.

Could the algae or other micro-organisms convert the Vitamin D3 always found in fish liver into D2? Again, it’s possible, but the process would have to involve adding an extra methyl group and a double bond. Let’s just say “it’s complicated” and my research turned up no organism on the planet that comes equipped to convert D3 into D2. Without further evidence, the idea that D3 could convert to D2 naturally in a “fermenting” liver appears improbable, if not impossible.

TESTING, TESTING

It’s far more likely that the putative D2 is — as Dr. Byrdwell’s research suggests — an artifact of UBE’s testing methods and not naturally present in the oil itself. In fact UBE’s testing methods have yielded improbably high levels of total Vitamin D in many other products. At the 2009 Wise Traditions conference in Schaumberg, IL, Sally Fallon Morell announced that UBE had found “astronomical values” for Vitamins A, D and K in pastured butter, lard, bear fat, caviar and other products. Although she acknowledged the figures were “off the charts,” she said she had “confidence in these numbers.”[19]

Let’s compare two of those UBE numbers to what’s found in standard nutritional databases. UBE found 74,560 IUs of Vitamin D in 100 grams of pastured lard (3,206 IU per teaspoon). That is nearly 300 times the 250 IU per 100 grams (10.8 IU per teaspoon) reported by Italian researchers in lard from pigs that see sunlight and pasture.[20] In contrast, the USDA has reported Vitamin D level for lard from factory-farmed pigs at a lowly 100 IU per 100 grams (4.3 IU per teaspoon). Similarly, UBE found 116,480 IU of Vitamin D in 100 grams of roe (500.9

IU per tsp), a figure that is over the top compared to the 232 IU per 100 grams (9.9 IU per teaspoon) reported in standard nutrition data bases.

Shortly after the 2009 conference, I alerted Fallon-Morell to the absurdity of these data from UBE Laboratories and later discussed them with Chris Masterjohn PhD, who said at the time that they would "only make sense in a parallel universe." More recently, he said he *might* be able to accept the figures if he only knew more about Danny Pang's methods. But Pang's not saying much about the unique and secret methods employed at UBE to Masterjohn or apparently anyone else.[21]

Fallon Morell now acknowledges "we're not so sure about these figures," but she would like to validate them.[22] Until then, the high Vitamin A and D fermented cod liver oil data from UBE remain up on both the Weston A. Price Foundation and Green Pasture websites.

SINKING TO A NEW LOW

High levels of Vitamins A and D can be toxic so it makes little sense that the extraordinary levels reported for the Green Pasture product would even be desirable. In fact, the average levels of A and D found in most cod, skate or other liver oils would more than suffice for attainment of optimal health. FCLO, however, tested surprisingly low in Vitamin D3 as per data coming from Lab #1 (1,760 IU/100g or 78.07 IU/tsp) and #7 (4,770 IU/100g or 211.60 IU/tsp).

The low levels of Vitamin D3 found in FCLO are not entirely surprising. Over the past several years, a number of doctors and other health care professionals have reported severe vitamin D deficiencies among some patients who have been taking daily doses of FCLO for months and even years. As measured by the 25(OH)D blood test, many FCLO consumers show levels under the cut-off point of 30 ng/mL, with some even dipping into the severe deficiency zone of under 10 ng/ML. Many theories about the cause of this have been bandied about on internet forums, ranging from defective and damaged receptor sites to exceptionally high personal needs. No amount of FCLO seems to help these people, yet Vitamin D3 supplements have moved their numbers into a healthy range.[23]

Only rarely has anyone asked the obvious question of whether the Green Pasture product is actually rich in Vitamin D. Sadly, many of these people experiencing Vitamin D deficiencies have been pregnant and lactating mothers, growing children and people with serious health challenges who've relied on FCLO's promises for their Vitamin D needs.

Could FCLO's high hydrolytic rancidity be adversely affecting its Vitamin D levels? Rancidity can definitely compromise the quality and quantity of many vitamins. Yet Vitamin D has traditionally seemed the exception to the rule — a trooper that can survive early stage rancidity and still do a body good. Indeed, that's the likely reason clinicians during Dr. Weston A. Price's lifetime reported benefits for malnourished individuals despite the rancidity found in most of the cod liver oils sold during that era. Whether Vitamin D can survive severe late stage rancidity is the unanswered question. Certainly FCLO's high degree of rancidity and low level of Vitamin D suggest that as a strong possibility.

NOT A CODSEND?

Could the problem be that FCLO might not come from cod? It's a good question, although most fish livers provide more than adequate levels of Vitamin D.

The textbook *Bailey's Industrial Oil and Fat Product* reports the Vitamin D levels of some common fish liver oils as follows:

- Cod Liver 60-120 IU/g (258-516 IU/tsp)
- Saithe liver 80-200 IU/g (344 to 860 IU/tsp)
- Ling Liver 100-200 IU/g (430-860IU/tsp)
- Haddock liver 50-100 IU/g (215-430 IU/tsp)
- Dogfish liver 10-30 IU/g (43-129 IU/tsp) a
- Porbeagle liver 50-100 IU/g (215-430 IU/tsp)
- Halibut liver 1000-2000 IU/g (4300-8600 IU/tsp)[24]

As these figures suggest, it's normal for the levels of Vitamin D in fish liver oil to vary, and the ratio of Vitamin A to D tends to vary quite a bit as well. Dogfish liver is high in Vitamin A but low in D; skate is low in A but high in D, halibut is extremely high in both. In addition to species differences, levels and ratios are affected by feeding habits, age and size of the fish, season and climate.[25,26]

Vitamin D tested as extremely low in FCLO, according to Lab #1. Of the seven oils tested for the Eagle Fisheries report, only dogfish liver was extremely low in Vitamin D. Could Green Pasture be using dogfish livers? Dogfish is a member of the shark family that is cheap, available and mostly caught as by-catch off the west coast and Alaska. Compared to FCLO, dogfish liver oil is also adequately high in Vitamin A (1000 to 2000 IU/g or 4300-8600 IU/tsp). Its fatty acid profile is also passably close.

Dogfish oil also has a long history of being substituted for cod liver oil. In a letter published in the journal *Industrial and Engineering Chemistry,* dated March 16, 1925, a chemist named A. Chaston Chapman wrote, “Dogfish liver oil has been examined physiologically” and “as a source of the fat-soluble, growth-promoting accessory substance, it was equal to medicinal cod liver oil.” [27] Equal or not, back then, many unscrupulous, profit-minded manufacturers either diluted cod liver oil with cheap dogfish oil or substituted it completely to maximize profits. Dogfish oil came into its own during World War II when Norway fell to the Nazis and cod liver oil became unavailable. The U.S. military then started promoting Vitamin A-rich dogfish oil as the right stuff to improve the night vision of soldiers facing Japanese soldiers in night combat.[28] Although the military developed a market for dogfish oil, sales fizzled after the war when synthetic supplements entered the marketplace. So, yes, dogfish oil could be a contender. Is Green Pasture actually using it? For the results of DNA testing,see Section V.

Could FCLO’s vitamin D levels match up with Alaskan pollock? Levels of Vitamin D in pollock oil run the gamut from extremely low to high, depending upon whether or not it is spawning season and other factors. Of the four pollock samples tested at Biomed, Inc. in Seattle for the 1998 Eagle Fisheries report, the lowest came in at less than 40 IU per gram for a liver taken during spawning season. (Because 40 IU was the cutoff for the testing, the amount of Vitamin D found in a teaspoon could be anywhere from 177 IU on down to zero.) The other three samples were 110 IU per gram (488 IU/tsp), 180 IU per gram (798 IU/tsp), and 1204 IU per gram (5341 IU/tsp).[29]

Could the sample of FCLO tested by Lab #1 have come from pollock caught during the spawning season? The numbers are close enough yet Eagle Fisheries reported the very highest levels of Vitamin A in the spawning-season sample. At 930 IU per gram, it is considerably higher than the 732 IU per gram found by Lab #2. However, data from additional samples might well show a wider range. What does DNA testing of the Green Pasture liver show? Hold tight for the answer in Section V.

SPECIAL K

Sally Fallon Morell says,“We know fermented cod liver oil has some Vitamin K in it”[30] and Wetzel claims he’s found stupendous amounts of it. “Fermentation,” he says, “increases the total quinone count by 700 to 1600 percent compared to readings prior to the fermentation process.” Wetzel admits he has “not identified the specific quinones” but “suspects” Vitamin K2 and Coenzyme Q10 will be “important components within the quinone nutrients.”[31-33]

Quinones and their derivatives are the active molecules needed for many biological processes including photosynthesis and aerobic respiration. Phylloquinone is Vitamin K1 synthesized by plants and found in highest amounts in leafy vegetables because it is directly involved in photosynthesis. Fish, animals and bacteria can convert K1 into Vitamin K2 or menaquinone, which includes valuable MK-4 and MK-7. Coenzyme Q10 is a fat-soluble, vitamin-like quinone commonly known as ubiquinone.[34]

The Green Pasture website reports quinones at levels of 5.65 to 17.06 mg/mL for the years 2012 and 2013, and at levels as high as 34.15 in 2011.[35] Whether these refer to Vitamin K or a mix of Vitamin K and other quinones is anyone's guess. They are definitely high numbers, well over the amounts found in Vitamin K rich foods like natto and goose liver paté.[36] If converted to mcgs, the unit used in most Vitamin K2 tables, the figures would look even more impressive. But if the data comes from UBE Laboratories, then the figures are probably as artificially high as those for Vitamin A and D.

For reliable Vitamin K testing, I sent a sample of FCLO to Lab #6, the world's leading Vitamin K research center, which tested it in duplicate. The results came back showing extremely low levels.

- Menaquinone-4 —13.83 and 11.73 ng/g
- Menaquinone-5 — 0 and 0
- Phylloquinone (K1) — 1.01 and 1.02 ng/g
- Menaquinone-6 —3.23 and 3.27 ng/g
- Menaquinone-7 — 0 and 0
- Menaquinone-8—1.12 and 1.16 ng/g
- Menaquinone-9 —1.26 and 1.19 ng/g
- Menaquinone-10 —0 and 0

That puts the total Vitamin K2 at 19.44 ng/g and 17.35 ng/g (0.01944 and 0.01735 mcg/g or 1.94 mcg/100g and 1.74 mcg/100g). Far from being high, the Vitamin K level of FCLO as tested here is just about zero.

Far better levels have been found in other brands of cod liver oil, including one brand that showed impressive K2 levels at 181.12 ng/g and 200.60 ng/g (0.18112 and 0.2006 mcg/g or 18.11 or 20.96 mcg/100 grams. The same brand had high Vitamin K1 levels as well, at 304.84 to 329.09 ng/g (0.30484 to 0.32909 mcg/g or 30.48 to 32.9 mcg/g. Compared to other quality brands, those levels are so improbably high that they seem spiked. Other brands came in at 1.83 and 1.68 ng/g; 8.90 and 9.92 ng/g; and 20.32 and 16.61 ng/g.[37]

By comparison, there's 1104 mcg/100g in natto, 369.0 mcg/100g in goose liver paté, 76.3 mg/100g in hard cheeses, 56.5 mg/100g in soft cheeses, and 32.1 mg/100g in egg yolk.[38] In plain English you'd have to swig a heck of lot of FCLO to come even close to the Vitamin K found in a serving of natto, paté or cheese.

Then how about that CoQ-10 that Wetzel promises? Lab #2 shows it as just about undetectable at less than 0.005 percent.

Lab #6 showed the quinones aren't coming from Vitamin K. So could the high levels of quinones showing up on Green Pasture's tests be coming from something else, perhaps from antibiotics? Yes, if Wetzel were "fermenting" farmed fish. To test this possibility, Lab #2 tested for 14 fluoroquinolones and quinolones. The good news is the high quinones his lab is reporting aren't coming from antibiotics. It would thus appear that the high levels might be the work of UBE Laboratories.

FISH-E

Fish livers tend to be low in Vitamin E. So it was not surprising to find low levels in FCLO. Lab #2 showed total Vitamin E at 10.1 mg/100 grams, of which all — or nearly all — is alpha tocopherol. Beta, gamma and delta tocopherol all tested at levels less than 0.1 mg/100 g. The preponderance of the alpha tocopherol form might lead people to conclude that Green Pasture adds synthetic alpha tocopherol as an antioxidant. Most fish and fish liver oil manufacturers do that. But that conclusion would probably be wrong. The fact is alpha tocopherol levels are so high in fish that they dwarf levels of the other tocopherols. And the total amount of Vitamin E found in the product seems about right.[39-41]

MAKING A PRODUCTION OF IT

Processing, refining, heat and chemical treatment can all have a negative impact on the nutrient content of liver oils. Although Wetzel disparages such "industrial"methods, the evidence is mounting that his ways may not be as "safe and natural" as he claims. What we know for sure is that Vitamins A, D and K are testing at levels well under what people have been encouraged to expect.

* * * * *

ENDNOTES

1. Fallon, Sally. Cod Liver Oil Basics and Recommendations. http://bit.ly/1WF6HVx

2. Product Test Data. Green Pasture website. http://bit.ly/1TTLHva Also discussion about Vitamin D2 in lectures, blogs and as online comments by Wetzel.

3. Author's discussions about D2 in cod liver oil with Sally Fallon Morell, Chris Masterjohn and others over the past several years.

4. Author's conversations with researchers, scientists and lab technicians. Michael Holick, the world's leading Vitamin D researcher, for example, wrote in an email dated March 11, 2013 "We have never found ergocalciferol in salmon or cod liver oil."

5. Farnworth, Edward R. *Handbook of Fermented Functional Foods* (CRC, 2nd edition, 2008). pp 133, 336, 360, 441.

6. Product Test Data. Green Pasture website. http://bit.ly/1TTLHva

7. Vitamin A, D, E and K, How much should I take? What are the little white crystals in the oil? Why does fermented cod liver oil taste, odor, color texture change from jar to jar? and other FAQ - Frequently Asked Questions at the Green Pasture website. http://bit.ly/1TTLHva

8. Author's conversations and emails with Sally Fallon Morell and Chris Masterjohn.

9. Email from Craig Byrdwell, August 14, 2014.

10. Byrdwell WC, DeVries J et al. Analyzing vitamin D in foods and supplements: methodologic challenges. *Am Soc Clin Nutr,* 2008, 88, 2, 554S—557S

11. email from Michael Holick, March 11, 2013. "We have never found ergocalciferol in salmon or cod liver oil."

12. Conversations with researchers, scientists and lab technicians.

13. Conversations and emails about D2 in cod liver oil with Sally Fallon Morell and David Wetzel from September through December 2014.

14. Rao DS, Raghuramulu N. Food chain as origin of Vitamin D in fish. *Comp Biochem Physiol* 114A, 1, 13-19.

15. Copping AM. Origin of vitamin D in cod-liver oil: vitamin D content of zooplankton. *Biochem J.* 1934, 28, 4, 1516–1520.

16. Algae Basics: Fermentation. All about Algae.http://bit.ly/1TTMb4u

17. Björn LO, Wang T. Is provitamin D a UV-B receptor in plants? *Plant Ecology,* 2001, 154, 1-2, 1-8.

18. Rao DS, Raghuramulu N. Food chain as origin of vitamin D in fish. *Comp Biochem Physiol* 1996, 114A, 1, 15-19.

19. Fallon Morell, Sally. Honoring the Sacred Foods, Wise Traditions 2009, November 2009 Schaumburg, Illinois. http://bit.ly/1My6mPO

20. Food Composition Database for Epidemiological Studies in Italy (Banca Dati di Composizione degli Alimenti per Studi Epidemiologici in Italia – BDA) published by the European Institute of Oncology. http://bit.ly/1LjBot5

21. emails from Fallon Morell and Masterjohn, October 15 and 19, 2014. Of UBE's figures for lard, Masterjohn also wrote,"That these values for lard can be so at odds with biological tests of antirachitic activity raises a red flag to me. It doesn't mean the UBE values are wrong. But with the level of secrecy that UBE employs, accepting the values means taking them as an article of faith, and with such red flags, I am not willing to make that leap of faith."

22. Conversations with Fallon Morell, October 2014 to July 2015.

23. Conversations with doctors, nutritionists and other health care practitioners at Wise Traditions, PaleoF(x), Ancestral Health, NTA and other conferences.

24. U.S. Market Prospects for Alaska Pollock Liver Oil. Eagle Fisheries, October 1998. Data extracted from *Bailey' s Industrial Oil and Fat Products* Volume 1, 1979, p 452. http://bit.ly/1E2jifm

25. Guil-Guerrero JL, Venegas-Venegas E et al. Fatty acid profiles of livers from selected marine fish species. *J of Food Comp Analysis*, 2011, 24, 2, 217-222.

26. Bimbo, Anthony P. Guidelines for Characterizing Food Grade Fish Oil. International Fishmeal and Oil Manufacturers Association.1998, 9, 473-483. http://bit.ly/1E1bgmJ

27. Chapman, Chaston A. Letter, *Journal of Industrial and Engineering Chemistry*, March 16, 1925.

28. Hitz, Charles R (Bob). Dogfish Shark Fishery — WWII- My Brother Jim, July 11, 2013. Carmel Finley: Historian of Science. http://bit.ly/1WFVowg

29. U.S. Market Prospects for Alaska Pollock Liver Oil. Eagle Fisheries, October 1998.http://bit.ly/1E2jifm The 411 on cod liver oil . . . and why our kids should be taking it.

30. Wendi Combes interview with Sally Fallon Morell, March 18, 2015. http://bit.ly/1NuxNL2

31. Wetzel, David. Returning to traditional production techniques for the quintessential sacred food. April 30, 2009. http://bit.ly/1LgGJl1

32. Part 2: Deeper Discussion; Why FCLO and High Vitamin Butter Oil. http://bit.ly/1TR8mZ3

33. Vitamin A, D, E, K etc. FAQ-Frequently Asked Questions. http://bit.ly/1IYSFqI

34. Vitamin K. Wikipedia. http://bit.ly/1TTNf8u

35. Products Test Data, Green Pasture website. http://bit.ly/1TTLHva

36. Rhéaume-Bleue, Kate. *Vitamin K2 and the Calcium Paradox* (Collins, 2012) p. 66-67.

37. Vitamin K data on four brands of cod liver oils shared by Maastricht University Vita K R&D Group. Brand names were not shared. August 20, 2015.

38. Rhéaume-Bleue.

39. Moore, T. Sharman, IM and Ward RJ. Cod-liver oil as both source and antagonist of vitamin E. *Br J Nutr.* 1959, 13, 1, 100-110.

40. Mattill HA, Golumbic C. Vitamin E, cod liver oil and muscular dystrophy. *J Nutr,* 1942, 22.

41. Conversations with marine oil experts.

SECTION V: SOMETHING FISHY

Fish oil is extracted from the flesh of tuna, herring, cod and other deep-sea oily fish species. It's valued for the omega-3 fatty acids EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) but considered a poor source of vitamins A and D.

Fish liver oil comes from the liver of the fish, not the flesh. Compared to fish oil, it is lower in EPA and DHA but far richer in Vitamins A and D. The ratio of EPA to DHA varies from species to species and is a useful tool for identifying the species of fish.[1] In the case of arctic cod liver, the EPA is always lower than the DHA, and the ratio is typically in the range of 6 to 10 or 9 to 14. The exact ratio will vary depending on age, size, food and habitat, but if it's off by much, it's not arctic cod.[2]

The EPA to DHA ratio of the Green Pasture Fermented Cod Liver Oil does not even come close.

A NOT SO GOLDEN RATIO

EPA and DHA figures from 20 samples taken from the years 2008 to 2014 are posted on the Green Pasture website.[3] Typical ratios are:

- 12.0 to 5.8
- 15.7 to 8.4
- 16.5 to 9.9
- 17.4 to 10.0.

Of all 20 sets on the Green Pasture website, only two showed an EPA lower than the DHA, and those were barely so at 11.3 to 11.4 and 9.4 to 9.6. Although the table identifies those two samples as FCLO, they closely match the EPA to DHA data for some of Wetzel's skate oil samples, suggesting a sample mixup or website typo. Whether or not this explains it, the ratios are closer — but not close enough — to true cod liver oil.

Results similar to Wetzel's tests came in from Lab #1, which reported an EPA to DHA ratio of 13.5 to 6.48. Similarly, Lab #7 in 2013 reported EPA to DHA at 16.21 to 7.44.

An unexpected finding came from Martin Grootveld of De Montfort University in Leicester, who analyzed a sample sent by Sally Fallon Morell, President of the

Weston A. Price Foundation.[4] His tests showed an EPA to DHA ratio of 9.24 to 6:16, which is not a ratio likely to be found with cod liver oil. Whether Grootveld did not notice this or chose not to be the bearer of bad news is unknown, but his letter to Fallon Morell makes no mention of the finding. His letter also misidentifies EPA (eicosapentaenoic Acid) as a 22:5 fatty acid and DHA (docosahexaenoic Acid) as a 24:6 fatty acid. The correct nomenclature for EPA is 20:5, and for DHA 22:6. (In chemistry shorthand, two numbers separated by a colon provide the chain length and number of double bonds.)

None of these numbers add up to arctic cod.

MYSTERIES OF THE DEEP

To be fair, Wetzel, has never advertised his “arctic cod” as from the North Atlantic though he’s not exactly disabused consumers of the notion either. His flavor name “Oslo Orange” certainly reinforces the impression of a Norwegian cod liver oil. In contrast his skate liver oil is advertised as “fished from the pristine waters of Alaska’s Aleutian Islands.”[5]

In fact, Wetzel has consistently evaded questions about the source of the livers for his FCLO product, sometimes whispering that his source is a mysterious unnamed Russian[6] and other times declaring he obtains all his livers from unnamed suppliers supposedly accredited by the Marine Stewardship Council.[7] Either way consumers have no information that could help them evaluate the authenticity and sustainability of his product. His use of the Marine Stewardship Council (MSC) name — with their implied stamp of approval — seems unauthorized. The MSC eco-label indicates the product is traceable through the supply chain back to the certified fishery to assure consumers it’s a truly sustainable seafood product and not mislabeled as such.[8] Boat-to-bottle transparency, of course, is impossible if a company is luring consumers with cod but delivering something else.

There are many species of cod in the world that Wetzel could be using, some of which have higher levels of EPA than DHA. Peruvian cod is a good example, and many unethical cod liver-oil producers substitute it for arctic cod in premium-priced products. Indeed, this happens so often that the cod liver oil industry has been wracked by the same kind of scandals found in the olive oil industry.[9]

Another strong contender is Alaskan pollock. Also known as walleye pollock, it’s a member of the cod family though most people would say it’s a stretch to call it cod. A 1998 report from Eagle Fisheries entitled *U.S. Market Prospects for Alaska Pollock Liver Oil*[10] reports EPA to DHA ratios on five samples as follows:

- 8.6 to 5.8
- 8.9 to 6.0
- 9.9 to 6.8
- 9.3 to 6.7
- 18.0 to 5.4

If the last ratio seems to be either an error or an outlier, it's not. With pollock there is always a "tremendous seasonal variation in omega 3 content," and it's typical for livers taken during the spawning season to show an extremely high EPA to DHA ratio.[11] The wide range looks suspiciously similar to the data gathered on FCLO's EPA and DHA.

CATCH ME IF YOU CAN

"The label said red snapper. The lab said baloney" was the title of a recent *Consumer Reports* expose on widespread fraud in the seafood industry.[12] Because most consumers want what they pay for — and people with allergies may stake their lives on it — authenticity and sustainability have become major issues in the fish and seafood industries.[13,14] As a result, laboratories are coming up with ever more sophisticated methods to verify identity, expose adulteration and even pinpoint the habitat.[15]

DNA technology can now accurately distinguish all common fish and seafood as well as most exotic species. Additionally, it can identify species of fresh, canned and frozen fish in readymade products so long as they are present at levels greater than ten percent.[16] Unfortunately, DNA procedures do not work well with oils.

Could Nuclear Magnetic Resonance (NMR) spectroscopy do the job? Lab #5 has been building a worldwide reputation for authenticity testing using state-of-the-art technology. Unfortunately, expensive testing only revealed FCLO to be "similar to cod, wild and not farmed." The lab could not identify FCLO conclusively because of high hydrolytic rancidity and interference from the "brown pigment." Color — such as the red of Krill Oil or the brown of FCLO— can confound results determined through any testing involving the color spectrum. On the plus side, Lab #5 provided additional confirmation of rancidity.

Clearly, DNA testing would be needed. Would it be necessary to beg, borrow or steal one of Wetzel's livers? That prospect seemed daunting, but it turns out he sells them. Not as fresh or frozen livers to be fried up or turned into paté, but as

sun-dried livers in the Green Pasture Cattle Lick Product. According to Green Pasture's website, the "cod livers" in the Cattle Lick product are left over from the manufacture of FCLO.

HOOKED!

Lab #3 pulls no punches. The liver is "100 percent Alaskan pollock."

RIGHT TO KNOW

Alaskan pollock is not just another word for cod. It's a favorite of Big Food, which turns it into fish sticks, fried fish, surimi and other fishy substances found in processed, packaged and fast foods. Alaskan pollock livers are primarily sold for use in pet food, and pollock liver oil is commonly substituted in "cod liver oils" coming out of China and other countries.[18,19] A popular saying is "you get what you pay for," but Green Pasture products are sold at premium prices to health-conscious consumers who think they are purchasing "cod liver oil" and who have trusted Green Pasture for "truth in labeling."

Will Wetzel argue that Alaskan pollock is a member of the cod family and say the mislabeling is just a little white lie with no consequences for consumers? Probably.

And he would not be entirely wrong. Scientists recently changed the scientific name of walleye pollock from *Theragra chalcogramma* to *Gadus chalcogrammus* after an extensive investigation of species and evolutionary relationships.[21] This fact doesn't absolve Green Pasture from mislabeling charges, however. Labeling their pollock liver oil as "cod liver oil" seems deceptive to consumers and may violate FDA and FTC regulations. It is definitely not in accordance with the Codex General Standard for the Labeling of Pre-packaged Foods, which attempts consumer protection with specific and separate labeling requirements for cod and pollock.[22]

What's more, most consumers think they have a "right to know," and few will to be pleased to learn they've been paying top dollars for a cheap product that has a very different nutritional profile from true North Atlantic cod. The fact that this "fermented" pollock liver oil is also testing as rancid, putrid and with low-to-average levels of vitamins A, D and K will cheer people even less.

Could a quality pollock-liver oil serve health-conscious consumers? Absolutely. But there are good reasons why the commercial fish industry has not developed a market for pollock liver oil products. For starters, pollock has a serious image problem. People have either never heard of it or know it as the cheap, generic fish found in fried fish and fake crab products.The deal breaker for makers of standardized supplements, however, is pollock oil's wildly fluctuating fatty acid and vitamin content.[23] Sellers of "all-natural" products,though, can choose to milk those same "ups and downs" as the work of Mother Nature herself.

On the plus side, Alaskan pollock can be sustainably fished. It's not an endangered species and it comes from comparatively uncontaminated waters (before Fukishima, at least.) That's one possible reason FCLO tested at Lab #1 and #2 as low in pesticides, heavy metals (except arsenic) and other toxins. In contrast, most true cod liver oils require extensive processing to reduce toxicity. Cod has also been overfished and is becoming an endangered species.

TRANS FATS

And that's not all, folks! The livers may be 100 percent Alaskan pollock, but FCLO itself appears to be diluted with something else. What that is, is the mystery, though the evidence points to a heat-damaged vegetable oil containing *trans* fats.

Lab #1 shows 3.22 percent *trans* fats, of which Dr. Gjermund Vogt, Project Manager for Eurofins Food & Feeding Testing Norway AS, and a leading authority on fish oils, says:

> *No authentic raw or mildly processed cod liver oil will contain* trans *fats. There should also be none present if the cod liver oil is mildly refined. The presence of* trans *C18:3 indicates that another oil has been added to this oil. This other oil must obviously be in sufficient quantities to detect the presence of these trans fats.*[24]

Here's why: Of the total 3.22 percent *trans* fats, Lab #1 has identified 2.40 percent as an 18.3 *trans* fat. This would derive from an 18.3 *cis* alpha linolenic fat, which would be typically found in pollock oil at levels ranging from 0.4 to 0.7. However, the level of 18.3 *cis* found in FCLO by Lab #1 and Lab #7 came in at 0.448 and 0.59, respectively. Both are on par with the level typically found in pollock oil.

The only way to achieve the level of 2.40 percent of 18.3 *trans* fat would be to add a thermally damaged vegetable oil. If the *trans* fats occurred because of heat damage to the fish liver oil itself, the levels would be no higher than the level of 18:1 *cis* alpha linolenic fat present in pollock oil.

FCLO also contains 18.1 *trans* fat at the level of 0.781 percent. Pollock oil contains 18.1 *cis*, which is a form of oleic acid, at 15.4 to 26.5 percent. Lab #1 and #7 report 18.1 *cis* in FCLO at the levels of 27.6 percent and 21.46 percent respectively.

Finally, FCLO contains an 18.2 *trans* fat at the level of 0.184 percent. This would be derived from an 18.2 *cis* linoleic acid, which is typically found in pollock oil at levels ranging from 0.7 to 1.0. Lab #1 and Lab #7 report the *cis* form at 1.12 percent and 0.94 percent respectively.

If all of this talk about *trans, cis* and so on sounds overly confusing and complicated, one thing is abundantly clear: neither a vegetable oil nor *trans* fats should be in FCLO.

Could these *trans* fats come from any other source than a thermally damaged vegetable oil? Apparently not. But an unanswered question remains: Is Green Pasture diluting the fish liver oil with vegetable oil or "fermenting" a readymade pollock/vegetable oil combination? If the latter, he would be taking the cost-cutting step of buying bottled pollock liver oils that — perhaps unbeknownst to him —have been diluted with vegetable oil. Readymade refined pollock oils would have several other added virtues as well: low biogenic amines as well as low heavy metals and other contaminants.This is a possible explanation for why the more recent products tested at Lab #1 and #2 seem "cleaner" than the earlier sample tested at Lab #7.

If so, Green Pasture would be following the path of the many commercial fish oil and fish-liver oil manufacturers of supplements who either add refined vegetable oils to their products or co-refine marine oils together with vegetable oils. Those manufacturers put vegetable oil in there for increased profits and/or added antioxidant protection. Is Wetzel doing this too? Is there any other reason vegetable oils and *trans* fats would be in there?

Could the *trans* fats in FCLO be none other than the healthy CLA (Conjugated Linoleic Acid) that has beneficial effects for weight management, immune function, cancer, diabetes, and atherosclerosis?[20] No. CLA comes from cows and other ruminant animals, not cod or pollock. CLA is also identified as C9 t10, t11 or t12, none of which are showing up in FCLO's fatty acid profiles from Labs # 1 and 7. CLA is also not found in the fatty acid data included in the Eagle Fisheries

report on pollock.[21] Then could the *trans* fat in FCLO be some kind of unique and special form of CLA found in fish, a fatty acid no marine oil expert has yet identified and no lab has ever reported? Sure, though that would seem to be yet another case of the Emperor's New CLO.

If the "fermenting" vegetable oil theory seems preposterous based on Wetzel's ongoing sales of Cattle Lick and fertilizer products made from spent livers, consider this: The FCLO myth requires he continue to buy and ferment some livers for appearances sake and to continue to give carefully orchestrated "grand tours" to the top bloggers and other "real food" royalty who have endorsed his product, encouraged its sales, and fostered the FCLO myth.

So what is Green Pasture actually up to? Further investigation is needed.

* * * * *

ENDNOTES

1. Bimbo, Anthony P. Guidelines for Characterizing Food Grade Fish Oil. International Fishmeal and Oil Manufacturers Association.1998, 9, 473-483. http://bit.ly/1E1bgmJ

2. Halver JE. Chapter 4. Lipids and Fatty Acids. Aquaculture Development and Coordination Programme. Fish Feed Technology, FAO Corporate Document Repository. http://bit.ly/1Nsbp4W

3. Products Test Data. Green Pasture website. http://bit.ly/1TTLHva

4. Grootveld Report. http://bit.ly/1JpnJ6l

5. Perfect Supplements statement about solar activation of Green Pasture fermented cod liver oil. http://bit.ly/1LjMfGn

6. Wetzel, David. Returning to Traditional Production Techniques for the Quintessential Sacred Food, April 30, 2009. Weston A. Price Foundation website. http://bit.ly/1LgGJl1

7. Environmental and Sustainability Statement. Green Pasture website. http://bit.ly/1Lid8HM

8. Marine Stewardship Council website. https://www.msc.org

9. Rohman A, Che Man, YB. Analysis of cod-liver oil adulteration using Fourier transform infrared (FTIR) spectroscopy. *J Am Oil Chem Soc,* 2009, 86, 12, 1149-1153.

10. U.S. Market Prospects for Alaska Pollock Liver Oil. Eagle Fisheries, October 1998. http://bit.ly/1E2jifm

11. Ibid.

12. "Mystery fish: The label said red snapper, the lab said baloney." *Consumer Reports* December 2011. http://bit.ly/1LibENH

13. Lou, Nicole. "Bait and Switch: The Fraud Crisis in the Seafood Industry." *The Atlantic,* March 19, 2015. http://theatln.tc/1fo5QXu

14. Warner K, Timme W, Lowell B, Hirshfield M. "Oceana Study Reveals Seafood Fraud Nationwide," February 2013. http://bit.ly/1gVppr5

15. Standal, IB, Axelson DE, Aursand M. Authentication of marine oils using ^{13}C NMR spectroscopy. *Lipid Technology*, 2011, 23, 7, 152-154.

16. Species analysis of fish and seafood. Eurofins. http://bit.ly/1TSDvWO

17. Fitzgerald, Tim. "Alaska Pollock Remains Good Seafood Choice despite Challenges." EDF (Environmental Defense Fund), January 14, 2010. http://bit.ly/1TSDPVy

18. Alaska Pollock. Wikipedia. http://bit.ly/1TTOogg

19. Oliveira, ACM, Miller MR. Purification of Alaskan walleye pollock (Gadus chalcogrammus) and New Zealand hoki (Macruronus novaezelandiae) liver oil using short path distillation. *Nutrients,* 2014, 6, 5, 2059-2076.

20. Yes, Virginia, Walleye Pollock is *Gadus chalcogrammus.* Alaska Fisheries Science http://1.usa.gov/1K4F

21. FAO Joint FAO/WHO Food Standards Programme. Codex Alimentarius Commission. 38th Session, CICG Geneva Switzerland, 6-11 July 2015. Report of the 24th Session of the Codex Committee on Fats and Oils, Melaka, Malaysia. February 9-13, 2015. http://bit.ly/1

22. U.S. Market Prospects for Alaska Pollock Liver Oil. Eagle Fisheries, October 1998. http://bit.ly/1E2jifm

23. emails from Gjermund Vogt, May 17 and July 6, 2015.

24. Conjugated Linoleic Acid. Wikipedia. http://bit.ly/1E5WbR5

25. U.S. Market Prospects for Alaska Pollock Liver Oil. Eagle Fisheries, October 1998. http://bit.ly/1E2jifm

SECTION VI: THE PRICE WAS RIGHT

What did Dr. Weston A. Price have to say about fermented cod liver oil?

In a word, **NOTHING.**

There's not one word about fermented cod liver oil in the 500 plus pages of *Nutrition and Physical Degeneration.* And it's not mentioned in Dr. Price's letters, journal articles, lecture notes or papers either. "It's taken us over a year to thoroughly search the archives," says Joan Grinzi, Executive Director of the Price-Pottenger Nutrition Foundation, but "we can now state that Dr. Price never mentioned fermented cod liver oil."[1]

Yet, for nearly a decade now, many people in the Weston A. Price Foundation, paleo and "real food" communities have promoted David Wetzel's Green Pasture Fermented Cod Liver Oil as the only true "traditional" cod liver oil and as the "high vitamin cod liver oil" recommended by Dr. Price.[2] However, even if the Green Pasture "cod liver" oil were from cod — and even if it could be proven to be a safe product — it would *not* be the cod liver oil recommended by Dr. Weston A. Price.

In brief, here's why:

Wetzel compares his "fermented" product to an "activated cod liver oil" recommended by Dr. Price, but the truth is the products are not even remotely the same. Dr. Price talked about an "activated cod liver oil" that had been exposed briefly to sunlight, but warned that "over activation" made an "injurious product."[3] He never recommended the oil be "fermented" for months at a time, and indeed warned that rancidity would become a problem if cod liver oil were "activated" for more than a few minutes.[4]

Dr. Price furthermore warned people to take the cod liver oil in "small quantities" or "very small doses."[5-9] In contrast, many people regularly take the Green Pasture "fermented" cod liver oil at doses of a teaspoon or more every day without fail. Many take even higher doses when under physical or mental stress.

Finally, Wetzel's claims that his methods are "traditional" and that "brown" cod liver oils have been used medicinally for millennia seem to represent a misreading of historical facts. Instead, pale, golden and light brown cod liver oils were valued for human consumption, and brown oils were used for lamp oils, paint and other industrial applications.[10]

ACTIVATION, NOT FERMENTATION

Dr. Price recommended "activating" cod liver oil by putting a bit of fresh raw cod liver oil — no more than one eighth of an inch deep — in a dish and letting it sit in the noonday sun for three to five minutes in the summer and from five to fifteen minutes in the winter.[11] That's *minutes,* not hours, not days, not weeks, and certainly not months. Price advised that the product should be stirred while being exposed and explained that "exposure for longer periods, say an hour or two, will produce a change in the oil so that very undesirable symptoms such as headache may develop."[12]

Wetzel's method is different — very different. Although explanations of his unique "fermenting" process vary, the version that most closely resembles Dr. Price's "activation" method came from Wetzel himself. For many months, the Green Pasture website stated: "We solar activate all our products as Dr. Weston A. Price did. Solar activation is simply exposing the product to the sun. Our plant is a solar plant and we ensure that all our oils are exposed the the sun, moon and stars."[13,14]

This might seem like a bright idea, but Dr. Price's method took just a few minutes whereas Wetzel's takes much longer. Descriptions of the Green Pasture method - as found on his website, from lectures and from conversations with consumers — give timetables of anywhere from months to a year. However long it takes, the evidence presented in Section I suggests it is probably not fermented and its pH is too alkaline to preserve a lacto-fermented product.

Dr. Price's method also involved stirring whereas Wetzel says his product is not stirred. And though Wetzel has repeatedly claimed his "natural methods" use "no heat" and "no high temperatures," visitors to his solar facility report the temperatures can reach extremely high temperatures, especially in the summer.

In contrast, Dr. Price sounded many warnings about "the abuse and possible serious injury that would be occasioned from exposing food overlong to ultraviolet light, whether from the sun or from an artificial generator, because of the production of substances distinctly deleterious to health."[15] He also wrote fish oils that have been exposed to the air may develop toxic substances.[16] As reported in Sections II and III of this report, "toxic substances" from rancidity and putrefaction are exactly what lab testing shows in Wetzel's product.

It's also a myth that Dr. Price found healthy people in primitive cultures eating lots of fermented foods. The truth is he mentioned fermentation only twice in *Nutrition and Physical Degeneration* — when he talked about poi with the Polynesians and wine with the Swiss. According to Joan Grinzi of PPNF, Dr. Price rarely mentioned fermentation in his other writings either.[17]

WARNINGS TO MOMS

Over the years Price offered many warnings to health-conscious moms:

> *"I have frequently had mothers bring this question to me as a serious nutritional problem with their children. They had desired to do all they possibly could for their children and, in their efforts, had tried to follow the directions on the bottle or as otherwise provided, which often meant large doses of cod liver oil. They have reported to me the difficulty they had in combating the rebellion of their children against the use of cod liver oil, which may have been in part a reaction of self-preservation. Many of the children were reported to regurgitate the oil when it was forced down. Since it has been demonstrated that only the oil that is utilized contributes to the well-being of the human being or animal, it can readily be anticipated that compulsion to take such a toxic product could be very injurious."*[18]

Yet many "real food" moms today think they are following the advice of Dr. Price when they force their kids to take the Green Pasture product. In contrast, Dr. Price instructed: "Just as soon as your child gets so he hates it, stop using it because when he or she does, it is a pretty sure sign that it is doing more harm than good."[19] In his writings, he most often recommended cod liver oil for severely malnourished children, saying the benefits for them would outweigh the risks. Although he did not clarify why, the most likely reason is some Vitamin D remains intact even in a rancid cod liver product. Unfortunately, Wetzel's product seems to be neither a cod liver oil nor high in Vitamin D, as discussed in Sections IV and V.

In short, Dr. Price was abundantly clear that the "disagreeableness" of cod liver oil was not a superficial matter of taste preference but rather a serious warning of rancidity and toxicity. In contrast, fans of FCLO think that its brown, smelly "disagreeableness" is proof of high potency and efficacy.[20]

Dr. Price was not alone in his concerns, and cited other researchers from the 1920s and 1930s who had "called attention to the importance of considering the toxic substances in cod liver oils as possible explanation for differences in results

obtained by different workers in vitamin studies."[21] He regretted the limitations of the research studies and chose to emphasize some "dangers that are not usually recognized or properly emphasized in the literature"[22] The adverse effects he found included physical and mental health problems, most notably depression and "serious structural damage" to the heart and kidneys by overdose.[23]

He always recommended small doses because he had "continually found evidence indicating that cod liver oil contains products that are very seriously toxic to humans and other land animals and can do much harm when given in large doses, even only as large as frequently advocated."[24]

HIGH FRUSTRATION

Despite the risks, Dr. Price considered "activated" cod liver oil to be one of the "best sources of stored-up activator known at present."[25] But he felt frustrated that testing showed inconsistent vitamin content not only in different brands of cod liver oils but in the same brand.[26,27] As a clinician, he needed to know the dose that would provide maximum help for malnourished, sick and injured patients with minimal toxic side effects. He warned against "regular drugstore cod liver oil" which he found to be very low in vitamin content.[28]

Dr. Price wanted to correct the assumption that cod liver oil is an adequate source of the fat-soluble vitamins, which is said "is not true for human beings, animals or birds."[29] I short, he did not consider cod liver oil to be a satisfactory source of fat-soluble activators in ordinary diets.

SYNERGY WITH BUTTER OIL

Dr. Price recommended cod liver oil be taken along with a high vitamin butter oil which contains "Activator X" because the butter oil would increase the benefits and reduce the risks.[30] Why exactly he thought butter oil could reduce the risk is unclear, but he wrote of "an apparent influence of the activators from butter in neutralizing toxic effects produced by cod liver oil."[31]

Can the Green Pasture Brand X Factor Gold High Vitamin Butter Oil do that? Can it magically transform FCLO's rancidity, putrefaction and other problems so that those risk factors will disappear? Is it a high-quality product that would have received Dr. Price's stamp of approval? Some answers are coming right up.

* * * * *

To read more about what Dr. Weston A. Price said about cod liver oil, visit the Price-Pottenger Nutrition Foundation's website — **ppnf.org** —and download their free eBook *What Dr. Price Said about Cod Liver Oil*.

* * * * *

ENDNOTES

1. Author's conversation with Joan Grinzi, Executive Director of the Price-Pottenger Nutrition Foundation at PaleoF(x), Austin, TX, April 25, 2015.

2. Dr. Price's name is consistently associated with Green Pasture products on the Green Pasture website, product labels, retail sites; at the Weston A. Price Foundation conferences, Facebook pages and chapter leader forums; and by many real food bloggers.

3. PPNF Archive #: W108 Page #: 685 (7) Archive Title/Info: Reprinted from *Industrial and Engineering Chemistry*, Vol. 18, No. 7, page 679, July, 1926 The Relation of Light to Life and Health Some Biochemical and Clinical Aspects By Weston A. Price Dental Research Laboratory, Cleveland, Ohio. Read before the Chemistry Session at the Second Chemical Equipment and Process Engineering Exposition, Cleveland, Ohio, May 10 to 15, 1926. "Over-activation of cod-liver oil makes an injurious product. One to 5 minutes in the bright summer sun and 5 to 15 in the winter are ample. Ten drops in a capsule is an average dose taken with 5 grains of calcium lactate. It is better to use raw oil than over expose. Never activate with quartz mercury lamp without filter."

4. PPNF Archive #: W110 Page #: 17 (18) Archive Title/Info: Chemical Metabolism Studies The Raising of Serum Calcium by Topical Applications of Raw and Activated Cod Liver Oil Disturbances Associated with the Active Dental Caries of Childhood and Pregnancy .Weston A. Price, D.D.S. Cleveland.Reprinted from the *American Journal of Diseases of Children,* January, 1927, Vol. 33, pp. 78-95 Copyright 1927. "The oil becomes rancid much more quickly after being activated."

5. Price, Weston A. *Nutrition and Physical Degeneration* (Price-Pottenger Nutrition Foundation, 8th edition, 2014) p. 267. **"**My investigations have shown that when a high vitamin natural cod liver oil is used in conjunction with a high-vitamin butter oil the mixture is much more efficient than either alone.[4] This makes it possible to use very small doses. Except in the late stages of pregnancy I do not prescribe more

than half a teaspoonful with each of three meals a day. This procedure appears to obviate completely the undesirable effects.

6. PPNF Archive #: W172Page #: 431 (16)Archive Title/Info: Eskimo and Indian Field Studies in Alaska and Canada. By Weston A. Price, D.D.S., M.S., F.A.C.D.Cleveland, Ohio. Reprinted from *The Journal of the American Dental Association*Vol. XXII, Pages 417-437, March, 1936 “This butter oil is mixed with equal quantities of a specially high vitamin natural cod liver oil. The quantity given is a teaspoonful of this mixture at the time of eating the special meal, which consists of natural foods for providing minerals in liberal quantity and in suitable chemical form.”

7. PPNF Archive #: W218 Page #: 28 (28)Archive Title/Info**:** The Relation of Vitamins to Health and Disease (This lecture was made by Dr. Weston A. Price before the Cleveland Sorosis, on Thursday Afternoon, December 20th, 1928.) “If you are sick - indeed if you are not sick - I would advise everyone here this afternoon to take at least twenty drops or thirty drops, a third of a teaspoonful of raw cod liver oil from November until April. You will get both vitamin A and D in that way. Now you will not be able to activate it to determine whether it will keep the diffusibility of your blood right. Perhaps you will not be able to put it in capsule form. I cannot take time for that more than to stress for you that you can get the vitamins in that simple way.”

8. PPNF Archive #: W259Page #: Unpaginated (3)Archive Title/Info: Transcript of a letter believed to have been written about 1934 - DDF. Weston A. Price, D.D.S., M.S. Dental Research Laboratories, 8926 Euclid Avenue, Cleveland, Ohio. “One of your greatest difficulties will be to provide the children and yourselves with sufficient of the fat-soluble activators and vitamins. We being mammals, have bodies prepared to get these from milk and its butter fat, which is not in skimmed milk. There is not much left for the children when the cream has been taken from the milk for the parents' coffee. Where possible, have June butter stored for winter use. Cod-liver oil can be given in moderate doses without injury and to great advantage. Seldom however, should the child be given more than a teaspoonful a day for extended periods, because of toxic effects that often develop. It is better to take the cod-liver oil with the meal rather than before or after, as it aids in the utilization of the minerals in the food.”

9. Price, *Nutrition and Physical Degeneration,* pp. 492-493 “Seldom however, should the child be given more than a teaspoonful a day for extended periods, because of toxic effects that often develop. It is better to take the cod-liver oil with the meal rather than before or after, as it aids in the utilization of the minerals in the food.”

10. Cod liver oil: a historical perspective. Price-Pottenger Nutrition Foundation, August 6, 2015. http://blog.ppnf.org/cod-liver-oil-a-historical-perspective/

11. PPNF Archive #: W110 Page #: 17-18 (18-19) Archive Title/Info: Chemical Metabolism Studies The Raising of Serum Calcium by Topical Applications of Raw and Activated Cod Liver Oil Disturbances Associated with the Active Dental Caries of Childhood and Pregnancy. Weston A. Price, D.D.S.Cleveland. Reprinted from the *American Journal of Diseases of Children,* January, 1927, Vol. 33, pp.78-95. Copyright 1927. "Cod liver oil is activated by placing it in an open dinner plate, in a layer not over one eighth of an inch deep, and exposed to the bright noonday sunshine for from three to five minutes in the summer, and from five to fifteen minutes in the winter. It should be stirred while being exposed. Exposure for longer periods, say an hour or two, will produce a change in the oil so that very undesirable symptoms such as headache may develop."

12. Ibid.

13. Do you solar activate your oils as Dr. Price did early in the 20th century? http://www.greenpasture.org/public/FAQ/ In August 2015, subsequent to the publication of the Price-Pottenger Nutrition Foundation's eBook *What Dr. Price Said about Cod Liver Oil* Wetzel took down his original post and replaced it with: "Our plant is exposed the sun but this does not equate to solar activation as Dr. Price discusses. Dr. Price had a specific protocol and definition for the term solar activation and it does not occur unless uv rays are directly exposed to the products. In our plant the products are not exposed to solar uv."

14. http://www.benaturallyprepared.com/collections/green-pasture "All of Green Pastures products are solar activated just as Dr. Weston A Price did. Solar activation is simply exposing the product to the sun. Their plant is a solar plant and they ensure that all of their oils are exposed the the sun, moon and stars.

15. PPNF Archive #: W107 Page #: 26 (26) Archive Title/Info: Newer Knowledge of Calcium Metabolism in Health and Disease, with Special Consideration of Calcification and Decalcification Processes Including Focal Infection Phenomena. By Weston A. Price, D.D.S., M.S., F.A.C.D.Cleveland, Ohio. Reprinted from *The Journal of the American Dental Association*, December, 1926. "In this connection, it is important to raise a note of warning for those who would advise or in any way be responsible for the abuse and possible serious injury that would be occasioned from exposing food overlong to ultraviolet light, whether from the sun or from an artificial generator, because of the production of substances distinctly deleterious to health. I have learned much from experimenting on myself, and one of the early safeguards that came from that source was secured as the result of severe headaches produced by taking cod-liver oil that had been exposed to ultraviolet rays from a mercury quartz vapor lamp for one half hour, even though the dosage was only a few drops."

16. Price, *Nutrition and Physical Degeneration,* p. 267.**"**The available evidence indicates that fish oils that have been exposed to the air may develop toxic substances."

17. Conversation with Joan Grinzi, Executive Director of the Price-Pottenger Nutrition Foundation, at Paleo f(x), Austin, TX, April 25, 2015.

18. PPNF Archive #: W133 Page #: 1358 (21) Archive Title/Info: Control of Dental Caries and Some Associated Degenerative Processes Through Reinforcement of the Diet with Special Activators. By Weston A. Price, D.D.S., M.S., F.A.C.D. Cleveland, Ohio. Reprinted from *The Journal of the American Dental Association,* Vol. XIX, Pgs. 1339-1369, 1932.

19. PPNF Archive #: W125 Page #: 37 (38)Archive Title/Info: *The Association Bulletin.* International Association of Milk Dealers, No. 10, Jan. 29, 1931, 228 N. La Salle St., Chicago. Some Means of Improving Human Life by Increasing the Vitamin Content of Milk and Its Products. By Weston A. Price, D.D.S., M.S., F.A.C.D. Cleveland, Ohio. Read before the International Association of Milk Dealers at Cleveland, Ohio, October 22, 1930 "QUESTION: What substitutions can be used for the capsules? DR. PRICE: 'The substitute for the capsules would perhaps be to go to the drug-store and buy cod liver oil, and just as soon as your child gets so he hates it, stop using it because when he or she does, it is a pretty sure sign that it is doing more harm than good.'"

20. Posts and comments from parents on health and nutrition blogs and Facebook groups. Author's conversations with people at Wise Traditions, Paleo f(x), Ancestral Health, NTA, and other conferences.

21.PPNF Archive #: W133 Page #: 1358 (21) Archive Title/Info: Control of Dental Caries and Some Associated Degenerative Processes through Reinforcement of the Diet with Special Activators. By Weston A. Price, D.D.S., M.S., F.A.C.D.Cleveland, Ohio. Reprinted from *The Journal of the American Dental Association,*Vol. XIX, Pgs. 1339-1369, August, 1932. "This shows the extreme toxicity of this substance. Little seems to have been reported on the toxic substances in cod liver oil. Recently, Norris and Church have called attention to the importance of considering the toxic substances in cod liver oils as possible explanation for differences in results obtained by different workers in vitamin studies."

22. Price, *Nutrition and Physical Degeneration,* p. 267.

23. Price, *Nutrition and Physical Degeneration,* p. 267. **"**It is important that I emphasize here some dangers that are not usually recognized or properly emphasized in the literature. When fish oils including cod liver oils are given in too large doses to some patients they experience quite definite symptoms of depression. The available evidence indicates that fish oils that have been exposed to the air may develop toxic substances. My work and that of others with experimental animals has demonstrated that paralysis can be produced readily by over-dosing. Serious structural damage can be done to hearts and kidneys. I have reported this in considerable detail."

24. PPNF Archive #: W126 Page #: 611-612 (8-9) Archive Title/Info: Reprinted from *American Journal of Public Health* and *The Nation's Health* Vol. XXI, No. 6, June

1931. View of Health and Disease Based on a Rise and Fall in the Levels of Life with Cycles in Vitamin Tides. Weston A. Price D.D.S. Published by the American Public Health Association, 450 Seventh Avenue, New York, N.Y. “In my clinical and technical investigations of the activators for inducing mineral metabolism, I have continually found evidence indicating that cod liver oil contains products that are very seriously toxic to humans and other land animals and can do much harm when given in large doses, even only as large as frequently advocated.”

25. PPNF Archive #: W112 Page #: 6 (6) Archive Title/Info: Calcium, Its Activation, Utilization and Metabolism. By Weston A. Price, D.D.S., M.S., F.A.C.D. Reprinted from *The Journal of the American Dental Association,* April, 1928. “Since the best sources of stored-up activator known at present is cod-liver oil, it has become important to consider carefully its advantages and disadvantages.”

26. PPNF Archive #: 228Page #: 13 (14) Archive Title/Info: Light from the Activators on the Phenomena of Life. Weston A. Price, D.D.S. “During the past decade I have been studying the relative values of the different cod liver oils for supplying the needs as activators. During the past eight years this has included a study of the biologic qualities both by animal feeding and by chemical analysis. It has been apparent continually that there is a marked difference in the efficiency of different samples of oil. As a part of the study to determine the reason for these variations I have had oils sent for testing from many places both for comparing districts and succeeding months of the same year for the same place and for different years. Others who have made investigations have reported a higher level of vitamins in the Newfoundland oil than for oils from most other places. In this regard a report of the Empire Marketing Board of Great Britain entitled “The Relative Values of Cod Liver Oils From Various Sources” by Drummond and Hilditch published by His Majesty’s Stationery Office, London, England strongly favors Newfoundland oils. Inasmuch as cod liver oils are only made during the summer months in Newfoundland territory with the exception of a few places in which winter fish are used it has not been possible for me to make curves for the entire year for the vitamin level of the cod liver oils as I have for milk products.”

27. PPNF Archive #: 212. Page #: Unpaginated (27) Archive Title/Info: New Fundamentals for the Prevention of Dental Disease, with Special Consideration of Calcification and Decalcification Processes Read Before The New Jersey State Dental Society, Asbury Park, New Jersey, April 19, 1928. By Weston A. Price, D.D.S., M.S., F.A.C.D.Cleveland, Ohio. “Any and all of these procedures have possibilities for both great good and great harm. It is therefore very important that the dangers of over treatment should be emphasized. Reduce to its simplest and safest form, it would seem that the administration of small doses, say from 1/8 gram to1½ g, of a mixture of raw cod liver oil and a cod liver oil that has been activated for 5 minutes in the sunshine, then placed in capsules and used before chemical change has been allowed to take place, will be the procedure of choice for the members of the dental profession, for use for increasing the defense. This problem is still complicated by the fact that there’s still a great difference in different samples of cod liver oil.

28. PPNF Archive #: W123 Page #: 1219 (31) Archive Title/Info: New Light on the Control of Dental Caries and the Degenerative Diseases. By Weston A. Price, D.D.S., M.S., F.A.C.D.Cleveland, OhioRead before the Section on Histology, Physiology, Pathology, Bacteriology and Chemistry (Research) at the Seventy-Second Annual Session of the American Dental Association, Denver, Colo., July 22, 1930. DISCUSSION R. M. Smith, Iowa Falls, Iowa: You spoke of cod-liver oil that one gets at drugstores as being very low in vitamin content? Dr. Price: It is high enough in vitamin D to pass government requirements, but it is not nearly so high as I require for my use. If I had time to use the slides, I could show what serious injurious effects are experienced from giving large doses of cod-liver oil.

29. Price, *Nutrition and Physical Degeneration,* p. 401. “It has generally been assumed that cod liver oil is an adequate source of the fat-soluble vitamins, but that this is not true for human beings, animals or birds is readily illustrated by the following experiment in which turkeys were used that were afflicted with weak legs.”

30. Price, *Nutrition and Physical Degeneration,* p. 267. **“**My investigations have shown that when a high vitamin natural cod liver oil is used in conjunction with a high-vitamin butter oil the mixture is much more efficient than either alone.[4] This makes it possible to use very small doses. Except in the late stages of pregnancy I do not prescribe more than half a teaspoonful with each of three meals a day. This procedure appears to obviate completely the undesirable effects.

31. PPNF Archive #: W133 Page #: 1357 (20) Archive Title/Info: Control of Dental Caries and Some Associated Degenerative Processes Through Reinforcement of the Diet with Special ActivatorsBy Weston A. Price, D.D.S., M.S., F.A.C.D.Cleveland, Ohio. Reprinted from The *Journal of the American Dental Association,* Vol. XIX, Pgs. 1339-1369, 1932. “In Figure 9 will be seen an apparent influence of the activators from butter in neutralizing toxic effects produced by cod liver oil. The clinical result from using these two products in the combination in which I now use them has afforded an abundance of important date, which will be discussed presently.”

SECTION VII: GETTING BUTTER

Dr. Weston Price revered his butter oil. The question is, would he recognize the Green Pasture X-Factor product that is being sold using his good name? And, if he did, would he think it has enough of the "right stuff" to overcome the rancidity, putrefaction, adulteration and low fat-soluble vitamin content that testing shows are found in the Green Pasture fermented cod liver oil product?

Because any butter, even a cheap one, will show adequate levels of Vitamins A and D, I focused on testing Vitamin K. Chris Masterjohn, after all, in his 2008 article "On the Elusive Trail of Activator X: A Sixty-Two-Year-Old Mystery Solved"[1] made a convincing case for Vitamin K2 being the mysterious "X Factor" identified by Dr. Price.

Astonishingly, Masterjohn's article came out more than seven years ago, but no one seems to have been curious enough — or spendy enough — to have tested butter oil or ghee for its reputed high Vitamin K2 content. As part of this investigation, I wanted to know if the Green Pasture X Factor Butter Oil would show superior levels of Vitamin K2. Or whether the amounts would only be en par with the 15 mcg/100 grams found in regular butter? Finally, how would the Green Pasture brand compare to quality butter oils or ghees.

OK or KO'd?

As tested at Lab #9, the leading Vitamin K research facility in the world, Green Pasture X-Factor Butter Oil showed very good levels of Vitamin K2. Not nearly as high as Vitamin K2 superstars like natto and goose liver pate, but impressive nonetheless.

- 393.84 ng/g (0.39384 mcg/g or 39.4 mcg/100 grams)
- 431.11 ng/g (0.43111 mcg/g or 43.1 mcg/100 grams)

A second brand of butter oil — also advertised as from pastured cows — was tested at the same lab, included in the Lab Data for this report as Lab #10. It showed decent levels of Vitamin K2 though at lower levels than the Green Pasture brand.

- 250.65 ng/g (0.25065 mcg/g or 25.07 mcg/100g)
- 259.89 ng/g (0.25989 mcg/g or 25.99 mcg/100g)

Four other samples of butter oil tested showed levels in the range of 196.37 to 263.70 ng/mg (0.19637 to 0.2637 mcg/g or 19.64 to 26.37mcg/100g)[2]

A high-quality, grass-fed ghee, as tested at Lab #10, showed levels of Vitamin K2 that were nearly as high as the Green Pasture X Factor Gold product:

- 335.70 ng/g (0.33570 mcg/g or 33.57 mcg/100 grams)
- 324.36 ng/g (0.32436 mcg/g or 32.44 mcg/100 grams)

Two other samples of ghee that were tested showed levels in the same range with a high of 367.45 ng/g (0.36745 mcg/g or 36.74 mcg/100 g) and low of 268.37 ng/g (0.26837 mcg/g or 26.84 mcg/100g).[3]

All these ghees tested significantly higher than ordinary butter, which typically has Vitamin K2 content of 15.0 mcg/100 grams. All three showed levels comparable to egg yolk, which typically offers a Vitamin K2 content of 32.1 mcg/100g. By comparison, the Vitamin K2 superstars are natto (1103.4 mcg/100g), goose liver paté (369.0 mcg/100g), hard cheeses (76.3 mcg/100g) and soft cheeses (56.5 mcg/100g).[4-6]

In her book *Vitamin K2 and the Calcium Paradox*, Kate Rhéaume-Bleue discusses two products that should be "chock-full of Vitamin K2 — the Green Pasture X-Factor Gold Butter Oil and Pure Indian Foods 100% Organic, Grass-fed Ghee. She writes she was "blown away by the flavor" of the "absolutely delicious" ghee, but wondered if the butter oil possessed any special attributes that could justify its higher cost.

> *Since the butter oil is seven times the price per ounce of grass-fed ghee, I did endeavor to determine exactly what distinguishes it. Except for the reference to an unstated species of grass on the butter oil label, the label descriptions of the two products seem the same. I interviewed the owner of Green Pasture Products and my specific questions were met with vague answers. If you can afford this product, you can afford grass-fed ghee and, according to my research, you'll be getting pretty much the same thing.*[7]

As it turns out, Rhéaume-Bleue was right — the grass-fed butter oils and ghees tested roughly comparable in terms of Vitamin K2. This raises the question of how plain butter from pastured cows would test. Would it test higher than regular butter, and conceivably reach the levels of K2 in the butter oils and ghees?

It turns out that some butters do test high in Vitamin K2, and at levels far over the supermarket butter average of 15 mg/g found in Dutch products. Indeed, researchers at Maastricht University Vita K and D Research Center have found results as high as 239.66 ng/g (0.23966 mcg/g or 23.97 mcg/100g) and with multiple samples in the 20.0 mcg/100 g range.[8]

THE STILL MYSTERIOUS X FACTOR

This strongly suggests that Vitamin K2 might not be Dr. Price's elusive "X Factor." Dr. Price was specific that it was butter oil — and not just butter — that had healing power and a potent synergizing effect on cod-liver oil. Clearly, it's time to test a variety of butters, butter oils and ghees not only for Vitamin K but for other potentizing factors.

Until then it looks like Vitamin K2 is not Dr. Price's mysterious "X Factor" after all.

LAND OF MILK AND HONEY

If not Vitamin K, might other factors distinguish the Green Pasture X-Factor Gold Butter Oil from its competition?

The Green Pasture myth holds that its butter oil is an "exquisite golden oil" extracted from the "milk of cows that graze on select grasses of the Northern Great Plains." The words vary from one retail site to another,[9-12] but the message is unmistakeable. This is a premium, all-American product made from the creamy milk of Shorthorn and Devon cows that graze exclusively on:

- "The fertile soils and green grasses of the Midwest"
- "Rapidly growing specialized forage ensuring optimal levels of Activator X"
- "The irrigated grass of the Northern Great Plains"
- "Specially selected, rapidly growing grass."
- "The green grasses of the northern Great Plains."

THE TRUTH?

Green Pasture once obtained its butter from trusted, local farmers and probably started out with butter from Wetzel's own herd of cows. But for several years now the company has imported its butter in large canisters from Argentina.[13,14] While it could conceivably be "spring butter" from pastured cows, it's not certified organic and hardly fresh by the time it's traveled north to Nebraska. Whether it's coming from herds of happy milking Shorthorn and Devon cows who feast on rapidly growing grass is anyone's guess.

What's known for sure is some visitors to Green Pasture have reported seeing canisters of butter that sit around unrefrigerated for weeks, heating up in the sun, and possibly going rancid. This may explain why so many butter oil connoisseurs have commented that the Green Pasture product has gone downhill over the past several years and is often marked by objectionable "off flavors" and an "odd texture."[16] Predictably, Wetzel frames the sensory perceptions differently. "Our High Vitamin Butter Oil will have a culture or fermented like flavor. Because we do not use industrial means, each lot can have different tastes, odors etc. . ."[17]

Taste, smell and texture are subjective impressions. For an objective evaluation of rancidity, a bottle of Green Pasture's butter oil went off to Lab #8.

According to the Codex Milk Fat Products Standards,[18] the Peroxide Value for a butter oil should be no higher than 0.6 meq/kg. Tested at the level of 3.6 meq/kg, the Green Pasture butter oil has already "turned" and is showing significant primary-stage rancidity. Codex Standards also specify a maximum Free Fatty Acids Value of 0.4. Multiplying by 1.99 yields a maximum acceptable Acid Value of 0.796 mg KOH/g. At 3.0 mg-KOH/g, the Green Pasture product tested at well above that.

The bottom line is, the sample was rancid. While that may not prove true of every batch, it's definitely a case of "buyer beware."

Can anything good be said about the product? Yes. Testing at Lab #8 showed non-detectable GMOs and antibiotic residue. Both would have shown up in butter from factory-farmed cows fed corn and soy and treated with antibiotics. So the butter purchased by Green Pasture could very well be coming from grass-fed cows, as the excellent Vitamin K2 levels would also suggest.

More testing is needed. Until then, there seem to be three strikes against the Green Pasture X-Factor Gold Butter Oil. The evidence indicates that the good Vitamin K2 levels are matched by grass-fed ghees that cost substantially less. It

comes from Argentina and so is not the all-American product demanded by truth in advertising. And, most important of all, Dr. Weston A. Price would never, ever have endorsed a product that tested rancid.

* * * * *

ENDNOTES

1. Masterjohn, Christopher. On the Trail of the Elusive X-Factor: A Sixty-Two-Year-Old Mystery Finally Solved, February 14, 2008. http://bit.ly/1JiuHbo

2. Vitamin K data on butter oil products shared by Maastricht University Vita K R&D Group. Brand names were not shared. August 20, 2015.

3. Vitamin K data on ghee products shared by Maastricht University Vita K R&D Group. Brand names were not shared. August 20, 2015.

4. Rhéaume-Bleue, Kate. *Vitamin K2 and the Calcium Paradox* (Collins, 2012) p. 66-67.

5. Elder SJ, Haytowitz DB, Howe J, Peterson JW, Booth SL. Vitamin K Contents of Meat, Dairy, and Fast Food in the U.S. Diet. *J Agric Food Chem*. 2006; 54: 463-467.

6. Schurgers LJ, Vermeer C. Determination of Phylloquinone and Menaquinones in Food. *Haemostasis*. 2000; 30: 298-307.

7. Rhéaume-Bleue, pp. 62-63.

8. Vitamin K data on butter shared by Maastricht University Vita K R&D Group. The high levels suggest pastured butters, but brand names were not shared. August 20, 2015.

9. http://bit.ly/1TVYEzo

10. http://bit.ly/1HWmjZH

11. http://bit.ly/1HWmjZH

12. http://bit.ly/1gXUKJM

13. http://bit.ly/1hpIUZQ

14. Conversation with Joey Jones of Prospect Farm, Texas. Jones is a former neighbor of David Wetzel who supplied local butter to Green Pasture.

15. Author's conversation with Ron Schmid of Dr. Ron's, a longtime reseller of the Green Pasture products. "At least a couple years ago, Dave told me he was getting at least some of his butter from Argentina."

16. Conversations with consumers at Wise Traditions and other conferences.

17. How is High Vitamin Butter Oil different from ghee and other butter oils. FAQ. Green Pasture website. http://bit.ly/1Jiyup7

18. Codex Standard for Milkfat Products CODEX Stan 280-1973 Codex does not offer a cutoff value for Anisidine Value so I was not able to evaluate the p-AnV of 4.1 reported by Lab #8.

CONCLUSIONS

Lab tests indicate the Green Pasture Fermented Cod Liver OIl is rancid; putrid; low in the fat-soluble vitamins A, D and K; apparently diluted with a *trans*-fat containing vegetable oil — and not even from cod. We have reliable reports that the X-Factor Gold Butter Oil comes from Argentina, not the Great Plains, and it tests rancid as well. And contrary to Green Pasture's advertising, Dr. Weston A. Price's own words make it clear that these are not products he would ever have endorsed.

Do you feel betrayed? Let down by the very health experts you trusted? Worried that you may have harmed your loved ones? Upset that you allowed "expert" opinion to override your own good common sense? Angry that you overpaid for a product that evidence indicates was not as labeled?

Then it's time to take back your power.

First, talk to friends and family who are taking Green Pasture products. Send them to **drkaayladaniel.com** to get their own free copy of this report.

Then take care not to be duped again.

- Know where your food is coming from. Boat to bottle. Farm to fork.
- Know how your food is grown and made. No secrets. No evasions.
- Be skeptical of health claims. If it seems too good to be true, it probably is. And being "all natural" doesn't change that.

Finally, if you think you have health challenges related to FCLO consumption, share your story with friends, colleagues . . . and me. If you think you've been harmed, I would like to offer you a FREE mini appointment by phone or face-to-face on Skype. To share your story or to make your appointment, contact me at **wholenutritionist@earthlink.net.**

* * * * *

Lab Reports

In order to do the necessary laboratory testing of the Green Pasture Fermented Cod Liver oil and X-Factor Gold Butter Oil, I was required to sign legal agreements with each of the analytical laboratories not to publish their original reports. For this reason, the lab names, letterheads, logos and any other identifying information have been blackened out. The remainder of the reports are shown exactly as I received them.

The FCLO and Butter Oil samples sent to Labs #1,2,4,5, 6 and 8 were purchased and sent to the laboratories by me. The Cattle Lick liver sample sent to Lab #3 was purchased and sent by a colleague who assisted me in this investigation.

The FCLO sample sent to Lab #7 and the butter oil and ghee samples sent to #10 were sent by other individuals, who generously agreed to share their data with me. I trust these individuals did not tamper with the samples. I find the data credible, consistent and a complement to my own findings.

This is a preliminary report based on limited data. More research is needed, with considerable funding required.

Lab #1

[redacted]

Certificate of Analysis

Report Number:	1194741-0
Report Date:	17-Mar-2015
Report Status:	Final
Supercedes :	1182753-0

The Whole Nutritionist LLC
412 Dartmouth Dr SE
Albuquerque New Mexico 87106 United States

Sample Name:	**Cod Liver Oil**	[redacted] **Sample:**	**3721885**
Project ID	WHOLE_NUTR-20150216-0001	**Receipt Date**	16-Feb-2015
PO Number	Charge/Visa	**Receipt Condition**	Ambient temperature
Sample Serving Size		**Login Date**	16-Feb-2015
		Storage Condition	5 (+/- 3) degrees Celsius
		Online Order	10

Analysis	Result
Fatty Acids Calculated as Triglycerides *	
Saturated Fatty Acids (Acid Form)	20.1 %
Total Cis Unsaturated Fatty Acids (Acid Form)	60.8 %
Monounsaturated Fatty Acids (Acid Form)	36.8 %
Polyunsaturated Fatty Acids (Acid Form)	24.0 %
Trans Fatty Acids (Acid Form)	3.22 %
Omega 3 Fatty Acids	23.2 %
Omega 6 Fatty Acids	1.81 %
Omega 9 Fatty Acids	21.2 %
Total Fatty Acids	88.0 %
4:0 Butyric	<0.060 %
6:0 Caproic	<0.060 %
8:0 Caprylic	<0.060 %
10:0 Capric	<0.060 %
12:0 Lauric	<0.060 %
14:0 Myristic	3.79 %
14:1 Myristoleic	0.090 %
15:0 Pentadecanoic	0.244 %
15:1 Pentadecenoic	<0.060 %
16:0 Palmitic	14.2 %
16:1 Palmitoleic	8.56 %
17:0 Heptadecanoic	0.093 %
17:1 Heptadecenoic	<0.060 %
18:0 Stearic	2.77 %
9c 18:1 Oleic	19.0 %
18:2 Linoleic	1.12 %
20:0 Arachidic	0.061 %
18:3 Gamma Linolenic	0.136 %
20:1 Eicosenoic	1.90 %
18:3 Linolenic	0.448 %
18:4 Octadecatetraenoic	2.04 %
20:2 Eicosadienoic	0.168 %

[redacted]

[redacted]

Certificate of Analysis

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Report Date:	**17-Mar-2015**
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PO Number	Charge/Visa	**Receipt Condition**	Ambient temperature
Sample Serving Size		**Login Date**	16-Feb-2015
		Storage Condition	5 (+/- 3) degrees Celsius
		Online Order	10

Analysis	Result
Fatty Acids Calculated as Triglycerides *	
22:0 Behenic	<0.060 %
22:1 Erucic	0.296 %
20:3 Eicosatrienoic	0.068 %
20:4 Arachidonic	0.387 %
20:5 Eicosapentaenoic	13.5 %
24:0 Lignoceric	<0.060 %
22:5 Docosapentaenoic	0.703 %
22:6 Docosahexaenoic	6.48 %
Total 18:1 trans	0.781 %
Total 18:1 cis	27.6 %
Total 18:2 trans	0.184 %
Total 18:3 trans	2.40 %
Vitamin D by LCMS	
Vitamin D3	17.6 IU/g
Vitamin D2	<0.0400 IU/g
pH	
pH	5.17
80-Compound Basic Pesticide Screen (GC/MS Only)	
Aldrin	<0.01 mg/kg
Bromopropylate	<0.01 mg/kg
Cadusafos	<0.01 mg/kg
Carbophenothion	<0.01 mg/kg
Chlordane, cis-	<0.01 mg/kg
Chlordane, trans-	<0.01 mg/kg
Chlorfenvinphos (E- and Z-isomers)	<0.01 mg/kg
Chlorpyrifos	<0.01 mg/kg
Chlorpyrifos-methyl	<0.01 mg/kg
Coumaphos	<0.01 mg/kg
Cyfluthrin (sum of isomers)	<0.02 mg/kg
Cyhalothrin, lambda-	<0.01 mg/kg
Cypermethrin (sum of isomers)	<0.02 mg/kg
Dacthal (DCPA, Chlorthal-dimethyl)	<0.01 mg/kg

[redacted]

[redacted]

Certificate of Analysis

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PO Number	Charge/Visa	**Receipt Condition**	Ambient temperature
Sample Serving Size		**Login Date**	16-Feb-2015
		Storage Condition	5 (+/- 3) degrees Celsius
		Online Order	10

Analysis	Result
80-Compound Basic Pesticide Screen (GC/MS Only)	
DDD, p,p'-	<0.01 mg/kg
DDE, p,p'-	<0.01 mg/kg
DDT, o,p'-	<0.01 mg/kg
DDT, p,p'-	<0.01 mg/kg
Deltamethrin	<0.01 mg/kg
Demeton-S	<0.01 mg/kg
Diazinon	<0.01 mg/kg
Dichlofenthion	<0.01 mg/kg
Dichlorvos	<0.01 mg/kg
Dicloran (DCNA)	<0.01 mg/kg
Dieldrin	<0.02 mg/kg
Disulfoton	<0.01 mg/kg
Endosulfan I (alpha-isomer)	<0.02 mg/kg
Endosulfan II (beta-isomer)	<0.02 mg/kg
Endosulfan sulfate	<0.02 mg/kg
Endrin	<0.02 mg/kg
EPN	<0.01 mg/kg
Ethion	<0.01 mg/kg
Ethoprophos (Ethoprop)	<0.01 mg/kg
Fenchlorphos (Ronnel)	<0.01 mg/kg
Fenitrothion	<0.01 mg/kg
Fenpropathrin	<0.01 mg/kg
Fensulfothion	<0.01 mg/kg
Fenthion	<0.01 mg/kg
Fenvalerate/Esfenvalerate	<0.02 mg/kg
Fipronil	<0.01 mg/kg
Fluvalinate, tau- (sum of isomers)	<0.02 mg/kg
Fonofos	<0.01 mg/kg
HCH, alpha- (alpha-BHC)	<0.01 mg/kg
HCH, beta- (beta-BHC)	<0.01 mg/kg
HCH, delta- (delta-BHC)	<0.01 mg/kg

[redacted]

[redacted]

Certificate of Analysis

Report Number:	1194741-0
Report Date:	17-Mar-2015
Report Status:	Final
Supercedes :	1182753-0

The Whole Nutritionist LLC

412 Dartmouth Dr SE
Albuquerque New Mexico 87106 United States

Sample Name:	**Cod Liver Oil**	[redacted] **Sample:**	**3721885**
Project ID	WHOLE_NUTR-20150216-0001	**Receipt Date**	16-Feb-2015
PO Number	Charge/Visa	**Receipt Condition**	Ambient temperature
Sample Serving Size		**Login Date**	16-Feb-2015
		Storage Condition	5 (+/- 3) degrees Celsius
		Online Order	10

Analysis	Result
80-Compound Basic Pesticide Screen (GC/MS Only)	
Heptachlor	<0.01 mg/kg
Heptachlor exo-epoxide	<0.01 mg/kg
Hexachlorobenzene (HCB)	<0.01 mg/kg
Lindane (gamma-HCH, gamma-BHC)	<0.01 mg/kg
Malathion	<0.01 mg/kg
Methacrifos	<0.01 mg/kg
Mevinphos (E- and Z-isomers)	<0.01 mg/kg
Methidathion	<0.01 mg/kg
Methoxychlor	<0.01 mg/kg
Mirex	<0.01 mg/kg
Oxadiazon	<0.01 mg/kg
Parathion-methyl	<0.01 mg/kg
Parathion	<0.01 mg/kg
Pentachloroanisole	<0.01 mg/kg
Pendimethalin	<0.01 mg/kg
Pentachloroaniline	<0.01 mg/kg
Pentachlorobenzene	<0.01 mg/kg
Permethrin (sum of isomers)	<0.01 mg/kg
Pentachlorothioanisole	<0.01 mg/kg
Piperonyl butoxide	<0.01 mg/kg
Phorate	<0.01 mg/kg
Phosalone	<0.01 mg/kg
Pirimiphos-ethyl	<0.01 mg/kg
Procymidone	<0.01 mg/kg
Pirimiphos-methyl	<0.01 mg/kg
Propetamphos	<0.01 mg/kg
Profenofos	<0.01 mg/kg
Propargite	<0.01 mg/kg
Propyzamide (Pronamide)	<0.01 mg/kg
Prothiofos	<0.01 mg/kg
Quinalphos	<0.01 mg/kg

[redacted]

[redacted]

Certificate of Analysis

Report Number:	1194741-0
Report Date:	17-Mar-2015
Report Status:	Final
Supercedes :	1182753-0

The Whole Nutritionist LLC
412 Dartmouth Dr SE
Albuquerque New Mexico 87106 United States

Sample Name:	**Cod Liver Oil**	[redacted] **Sample:**	**3721885**
Project ID	WHOLE_NUTR-20150216-0001	**Receipt Date**	16-Feb-2015
PO Number	Charge/Visa	**Receipt Condition**	Ambient temperature
Sample Serving Size		**Login Date**	16-Feb-2015
		Storage Condition	5 (+/- 3) degrees Celsius
		Online Order	10

Analysis	Result
80-Compound Basic Pesticide Screen (GC/MS Only)	
Quintozene (Pentachloronitrobenzene)	<0.01 mg/kg
Tecnazene	<0.01 mg/kg
Tetradifon	<0.01 mg/kg
Vinclozolin	<0.01 mg/kg

[redacted]

[redacted]

[redacted]

Certificate of Analysis

Report Number:	1194741-0
Report Date:	17-Mar-2015
Report Status:	Final
Supercedes :	1182753-0

The Whole Nutritionist LLC
412 Dartmouth Dr SE
Albuquerque New Mexico 87106 United States

Method References	Testing Location

Vitamin D by LCMS (VDMS_S:16) [redacted]

Official Methods of Analysis of AOAC INTERNATIONAL, Current Ed., Method 2011.11, AOAC INTERNATIONAL, Gaithersburg, MD, USA.

Huang, M., Laluzerne, P., Winters, D., Sullivan, D., "Measurement of Vitamin D in Foods and Nutritional Supplements by Liquid Chromatography/Tandem Mass Spectrometry," *Journal of AOAC International*, Volume (92), No. 5:1327-1335 (2009).

Testing Location(s) [redacted]

[redacted]

[redacted]

[redacted]

Sample Code: 464-2015-02170252
Sample Description: cod liver oil
Client Sample Code: Lot#00941
PO Number:
Client Code: QD0006244

Entry Date: 02/17/2015
Reporting Date: 03/10/2015

The Whole Nutritionist
attn: PhD Kaayla T. Daniel
412 Dartmouth Drive SE
Albuquerque, NM 87106

The Whole Nutritionist
Attn: PhD Kaayla T. Daniel
412 Dartmouth Drive SE
Albuquerque, NM 87106

CERTIFICATE OF ANALYSIS

[redacted]

Test	Result	
QD058 - Copper by ICP		**Completed: 02/27/2015**
AOAC 965.17 / 985.01 mod.		
* Copper	<1 ppm	
QD107 - Iron by ICP		**Completed: 02/27/2015**
AOAC 965.17 / 985.01 mod.		
* Iron	<0.0002 %	
QD06T - Cadmium (Mwd-ICP-MS)		**Completed: 02/28/2015**
J. AOAC vol. 90 (2007) 844-856 (Mod)		
* Cadmium (Cd)	<0.010 mg/kg	
QD06S - Lead (Mwd-ICP-MS)		**Completed: 02/28/2015**
J. AOAC vol. 90 (2007) 844-856 (Mod)		
* Lead (Pb)	<0.010 mg/kg	
QD06R - Mercury (Mwd-ICP- MS)		**Completed: 02/28/2015**
J. AOAC vol. 90 (2007) 844-856 (Mod)		
* Mercury (Hg)	<0.010 mg/kg	
QD06Q - Arsenic (Mwd-ICP-MS)		**Completed: 02/28/2015**
J. AOAC vol. 90 (2007) 844-856 (Mod)		
* Arsenic (As)	2.50 mg/kg	
QD00B - Free Glutamic Acid as MSG (AOAC, Most Matrices)		**Completed: 02/27/2015**
AOAC 999.13 mod.		
Glutamic Acid (Free)	<0.01 %	
MSG (calculated from free glutamic acid)	<0.01 %	
QQ182 - Total Vitamin A		**Completed: 02/26/2015**
AOAC 974.29 Mod		
* ß-carotene	<59.8 IU/100 g	
* Retinol	73,200 IU/100 g	
* Total Vitamin A	73,200 IU/100 g	
QQ188 - Vitamin E-Tocopherol Profile (AOAC, Most Matrices)		**Completed: 03/03/2015**
AOAC 971.30 with HPLC quantification mod.		
* Alpha-Tocopherol	10.1 mg/100 g	
* Beta-Tocopherol	<0.100 mg/100 g	
* Gamma-Tocopherol	<0.100 mg/100 g	
* Delta-Tocopherol	<0.100 mg/100 g	
* Total Vitamin E (Tocopherols)	10.1 mg/100 g	

[redacted]

[redacted]

AR-15-QD-028339-01

[redacted] **Sample Code:** 464-2015-02170252
Client Sample Code: Lot#00941

Test	Result	
QD094 - Free Fatty Acids (FFA)		**Completed: 02/24/2015**
AOCS Ca 5a-40		
* FFA (Free Fatty Acids)	16.2 %	
QD005 - Acid Value		**Completed: 02/24/2015**
AOCS Cd 3d-63		
* Acid value	32.3 mg KOH/g	
QD103 - Peroxide Value (PV)		**Completed: 02/25/2015**
AOCS Cd 8-53		
* Peroxide Value - Initial	0.2 meq/kg	
QD01P - p-Anisidine Value		**Completed: 02/25/2015**
AOCS Cd 18-90		
* p-Anisidine value	6.8	
QD222 - TBA Value		**Completed: 02/26/2015**
AOCS Cd 19-90		
TBA value	0.20	
UMJVV - Lactic acid bacteria - CMMEF Chapter 19.571		**Completed: 02/23/2015**
CMMEF Chapter 19.571		
Lactic acid bacteria	< 10 (est) cfu/g	
QA01S - Fluoroquinolones and Quinolones (LC-MSMS)		**Completed: 03/03/2015**
FDA LIB 4383		
Cinoxacin	< 10 µg/kg	
Ciprofloxacin	< 5.0 µg/kg	
Danofloxacin	< 5.0 µg/kg	
Difloxacin	< 10 µg/kg	
Enoxacin	< 10 µg/kg	
Enrofloxacin	< 5.0 µg/kg	
Flumequin	< 10 µg/kg	
Lomefloxacin	< 10 µg/kg	
Marbofloxacin	< 5.0 µg/kg	
Nalidixic acid	< 10 µg/kg	
Norfloxacin	< 5.0 µg/kg	
Ofloxacin	< 10 µg/kg	
Oxolinic acid	< 10 µg/kg	
Sarafloxacin	< 5.0 µg/kg	
KK00A - Coenzyme Q10, Oxidative Preparation (HPLC)		**Completed: 03/10/2015**
Internal Method		
Coenzyme Q10	<0.005 %	
DJ700 - Biogenic Amines (dansyl)		**Completed: 02/27/2015**
Czech J. Food Sci. Vol.21		
2-Phenylethylamine	10.3 mg/kg	
Spermine	< 1 (LOQ) mg/kg	
Cadaverine	2.52 mg/kg	
Histamine	2.26 mg/kg	
Putrescine	< 1 (LOQ) mg/kg	
Spermidine	< 1 (LOQ) mg/kg	
Tryptamine	7.61 mg/kg	
Tyramine	8.81 mg/kg	

**The test result is covered by our current A2LA accreditation.*

[redacted]

[redacted]

REPORT OF ANALYSIS

Customer: **The Whole Nutritionist**
412 Dartmouth Drive SE
Albuquerque, NM 87106

Date Received: 04/06/15
Report Date: 04/13/15

‡Description: Cod Liver Oil Lick Tub
[redacted]
Commodity: Cod Livers

Analysis	Result	Analyzed
Species COI DNA sequence		04/13/15
Scientific name	*Gadus chalcogrammus*	04/13/15
% Homology	100%	04/13/15
Approved Market Name(s)	Pollock or Alaskan Pollock	04/13/15

‡The results shown in this report relate solely to the item submitted for analysis.

[redacted]

[redacted]

[redacted]

REPORT DATE
Mar 06, 2015
RECEIVED DATE
Feb 26, 2015

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ISSUE DATE
Mar 06, 2015

THE WHOLE NUTRITIONIST
KAAYLA T DANIEL PHD
412 DARTMOUTH DR SE
ALBUQUERQUE NM 87106

REPORT OF ANALYSIS
For: (35690) THE WHOLE NUTRITIONIST
FISH OIL

Analysis	Level Found As Received	Units	Reporting Limit	Method	Analyst-Date	Verified-Date
[redacted]						
Aerobic plate count	n.d.	cfu/g	1	AOAC 990.12	bji8-2015/02/28	arj0-2015/03/01
E. coli (generic)	n.d.	cfu/g	10	AOAC 991.14 *	bji8-2015/02/28	arj0-2015/03/01
Total coliforms	n.d.	cfu/g	10	AOAC 991.14 *	bji8-2015/02/28	arj0-2015/03/01
Salmonella	negative	org/25g	1	RapidChek *	tma2-2015/02/28	bji8-2015/02/28
Staphylococcus aureus	n.d.	cfu/g	10	AOAC 2003.07 *	arj0-2015/02/27	kej7-2015/02/27
Yeast	n.d.	cfu/g	10	FDA/BAM Chapt. 18 *	bji8-2015/03/03	kej7-2015/03/03
Mold count	n.d.	cfu/g	10	FDA/BAM Chapt. 18 *	bji8-2015/03/03	kej7-2015/03/03
Listeria	negative	org/25g	1	RapidChek/AOAC RI 020401 *	tma2-2015/02/28	bji8-2015/02/28
Lactobacillus homofermentative	n.d.	cfu/g	10	MEF 19 *	bji8-2015/02/28	arj0-2015/03/01
Lactobacillus heterofermentative	n.d.	cfu/g	10	MEF 19 *	bji8-2015/02/28	arj0-2015/03/01
2-phenylethylamine	n.d.	ppm	1.0	LC/MS	aln9-2015/03/06	slg7-2015/03/06
Cadaverine	n.d.	ppm	1.0	LC/MS	aln9-2015/03/06	slg7-2015/03/06
Histamine	n.d.	ppm	1.0	LC/MS	aln9-2015/03/06	slg7-2015/03/06
Putrescine	n.d.	ppm	1.0	LC/MS	aln9-2015/03/06	slg7-2015/03/06
Spermidine	n.d.	ppm	1.0	LC/MS	aln9-2015/03/06	slg7-2015/03/06
Spermine	n.d.	ppm	1.0	LC/MS	aln9-2015/03/06	slg7-2015/03/06
Tryptamine	n.d.	ppm	1.0	LC/MS	aln9-2015/03/06	slg7-2015/03/06
Tyramine	n.d.	ppm	1.0	LC/MS	aln9-2015/03/06	slg7-2015/03/06
TBA value	0.28	mg/kg	0.02	J. FOOD SCI	mnp3-2015/03/03	ems4-2015/03/03

[redacted]

[redacted]

REPORT DATE
Mar 06, 2015
RECEIVED DATE
Feb 26, 2015

REVISE DATE
Mar 06, 2015

THE WHOLE NUTRITIONIST
KAAYLA T DANIEL PHD
412 DARTMOUTH DR SE
ALBUQUERQUE NM 87106

REPORT OF ANALYSIS

For: (35690) THE WHOLE NUTRITIONIST
FISH OIL

Analysis	Level Found As Received	Units	Reporting Limit	Method	Analyst-Date	Verified-Date
[redacted]						
p-anisidine value	13		2	AOCS Cd 18-90 *	[illegible]	[illegible]
Peroxide value	n.d.	[illegible]	2.0	MWL FO PROC 33 *	[illegible]	[illegible]
Acid value	27.97	[illegible]	0.50	AOCS CD 3D-63	[illegible]	[illegible]
Moisture (vacuum oven)	n.d.	%	0.1	Multi *	[illegible]	[illegible]

All results are reported on an AS RECEIVED basis., n.d. = not detected , cfu = colony forming unit , ppm = parts per million, ppm = mg/kg

[redacted]

[redacted]

[redacted]

Mar 06, 2015
RECEIVED DATE
Feb 26, 2015

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Mar 06, 2015

THE WHOLE NUTRITIONIST
KAAYLA T DANIEL PHD
412 DARTMOUTH DR SE
ALBUQUERQUE NM 87106

REPORT OF ANALYSIS
For: (35690) THE WHOLE NUTRITIONIST
FISH OIL

Detailed Method Description(s)

E coli and Total Coliform

Sample analysis follows [redacted] which is based on AOAC 991.14. A representative 25 Â± 0.5 g is obtained and placed in a stomacher bag along with 225 mL of phosphate buffer. The stomacher bag is blended to homogenize the sample. Aliquots of the sample are withdrawn and placed on the Petrifilmâ„¢ plates. After the plates are prepared, they are incubated for 48 Â± 4 hours at 35 Â± 1Â°C. After samples are incubated, plates are counted to determine the number of generic E. coli and total coliform present. The color of the colony and the presence of gas differentiate a coliform from E. coli. Additional confirmation as total coliform can be carried out using a Brilliant Green Bile (BGB) selective media for an additional 48 Â± 2 hours when requested by clients to confirm Total Coliforms.

Salmonella - Lateral Flow

Samples are analyzed following [redacted] which is based on the RapidChek Select Salmonella Test Kit User Guide 3090045 V.10 13/11/12. A representative sample is obtained using aseptic technique. The sample is combined with a primary growth media and allowed to incubate. After the required time, an aliquot of the material is added to a secondary selective media and allowed to incubate. After the second period of incubation, a test strip is used for Salmonella determination. If a single line appears, the sample is negative and if a double line appears, it is positive. This method does not provide a count as it can only report positive or negative results.

Staph aureus by 3M petrifilm by AOAC 2003.07

Sample analysis follows [redacted] which is based on AOAC 2003.07 and AOAC 2003.11. Representative samples are obtained and added to phosphate buffer at a ratio of 9 parts media to 1 part sample (9:1). Samples are placed on 3M Petrifilm and incubated for 24 hours. After the incubation period, plates are counted and reported as colony forming units.

Yeast and mold FDA/BAM Chapter 18

Sample analysis follows [redacted] which is based on FDA/BAM Chapter 18. Samples are obtained and added to phosphate buffer at a 9:1 ratio or a pre-determined volume if a swab or sponge. Sample aliquots are removed to provide a dilution series on PDA (potato dextrose agar) and incubated at 25 degrees C for five (5) days. Colonies on the plates are counted and the results issued in cfu/g, cfu/swab, cfu/sponge, or other unit depending on the type of sample.

[redacted]

[redacted]

REPORT DATE
Mar 06, 2015
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THE WHOLE NUTRITIONIST
KAAYLA T DANIEL PHD
412 DARTMOUTH DR SE
ALBUQUERQUE NM 87106

REPORT OF ANALYSIS
For: (35690) THE WHOLE NUTRITIONIST
FISH OIL

Listeria by lateral flow

Samples are analyzed following [redacted] which is based on lateral flow technology licensed as RapidClick. A representative sample is obtained using aseptic techniques. The sample is combined with growth media and allowed to incubate. After the required incubation time, an aliquot is boiled for 10 minutes, and a test strip for Listeria determination is used. The test strip contains antibodies specific for Listeria antigens. If a single line appears, the sample is negative and if a double line appears, it is positive. This method does not provide a count as it can only report positive or negative results. This procedure does not speciate a Listeria type.

Lactobacillus MEF

Samples are analyzed following [redacted] which is based on Compendium of Method for the Microbiological Examination of Foods (MEF) XIX. A representative 25g sample is obtained and placed in a stomacher bag along with 225 mL of phosphate buffer. The stomacher bag is masticated to homogenize the material. Aliquots of the sample are withdrawn and plated. MRS agar is poured into the Petri dishes. The plates are inverted and incubated for 48 Â± 2 hours at 35 Â± 1Â°C. After incubation, the colonies are counted using a lighted Quebec counter to determine the number of colonies on the selective media plate. A record of the count and dilution issued to obtain the final count is recorded.

Anisidine value

The procedure is based on modified [redacted] The fat in a sample is extracted and then dissolved into iso-octane. The p-anisidine reagent is added and the resultant solution read at 350 nm.

MWL FO Procedure 33

Peroxide value analysis is carried out using [redacted] which is based on AOAC 965.33 and AOCS Cd 8b-90. Samples are treated with a solvent that removes the fat and the fat-solvent solution treated with potassium iodide. The solution is titrated with sodium thiosulfate to measure the free iodide. A calculation is carried out to measure the peroxide value.

[redacted]

REPORT DATE
Mar 06, 2015
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THE WHOLE NUTRITIONIST
KAAYLA T DANIEL PHD
412 DARTMOUTH DR SE
ALBUQUERQUE NM 87106

REPORT OF ANALYSIS
For: (35690) THE WHOLE NUTRITIONIST
FISH OIL

Vacuum moisture

Analyses follows [redacted] which references individual AOAC methods for specific materials including beef powders (AOAC 990.19), sugar (AOAC 925.45), pasta (AOAC 926.07), nuts (AOAC 925.40), and others. Samples are weighed in a tin and placed in a special oven that can be sealed, a vacuum produced and temperature regulated. Depending on the material, the amount of sample, vacuum level, temperature, and heating time are followed. After the specified time the samples are re-weighed and the loss in mass is reported as vacuum moisture.

[redacted]

[redacted]

Report

Analysis of oil sample SO

Species and oxidation status

[redacted]

[redacted]

[redacted]

Report

Analysis of oil sample SO

Species and oxidation status

VERSION	DATE
1	2015-02-19

[redacted]

[redacted]

[redacted]

Table of contents

1 [redacted]

2

3

4

1 Introduction

[redacted] An evaluation on species (cod liver oil or not) will be made based on previous 13C NMR analyses of fish oil (calculation of SN-2 specificity for DHA and EPA, as well as a visual comparison). A semi-quantitative evaluation of the lipid classes based on 13C NMR will also be performed. If the sample is a mixture of different species, it will most likely be difficult to say anything certain about relative amounts or the identity of the different components in the mixture. An evaluation of the oxidation products present in the mixture will also be performed by 1H NMR. The results will be summarised in a short report.

2 Results

2.1 Semi-quantitatively analyses of lipid classes:

From the ^{13}C NMR glycerol region (see Figure 1), it can be seen that the main lipid class in the sample is triacylglycerols (TAG), followed by diaclyglycerols (DAG), and monoacylglycerols (MAG). By integration of the relevant peaks , the levels of the different acylglycerol-species was calculated to be approximately:
TAG : 84%, 1,3-DAG : 10%. 1,2-DAG : 3% and 1-MAG: 3%
(reported as mole % of total acylglycerol species). Peaks from cholesterol could also be observed in the sample (results not shown). Ethyl esters, usually identified by a peak at 60 ppm, were not observed.

[redacted]

[redacted]

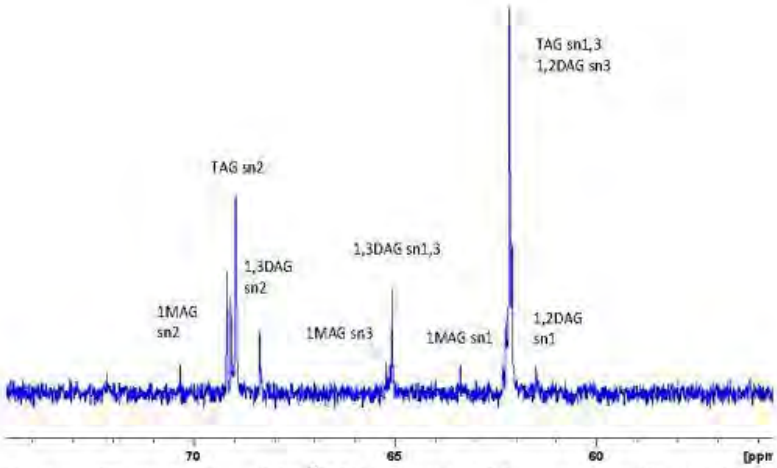

Figure 1. Glycerol region of the ^{13}C NMR spectra of the current sample. Acylglycerol species: TAG: triacylglycerols, DAG: diacylglycerols, MAG: monoacylglycerols.

Also ^{1}H NMR can be used to evaluate acylglycerol-species present (Figure 2). ^{1}H NMR is a more sensitive technique than ^{13}C NMR, however, due to overlapping of peaks, it is difficult to evaluate 1,3-DAGs content when TAGs are present. The ^{1}H NMR spectrum confirms that both 1,2DAGs and 1-MAGs are present, and also that 2-MAGs can be observed, but the levels are lower than for 1-MAGs (and too low to be detected in ^{13}C NMR by the number of scans employed).

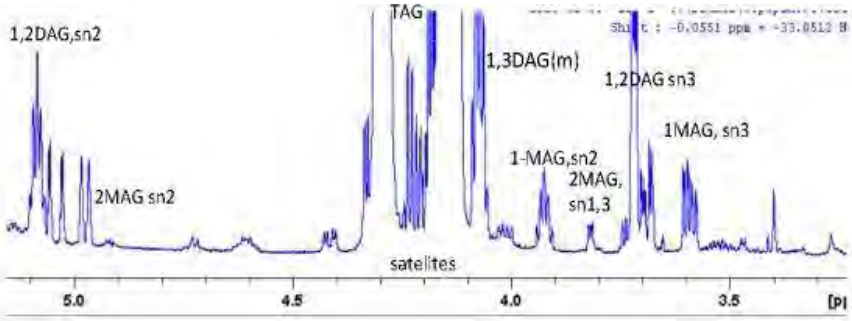

Figure 2.

[redacted]

[redacted]

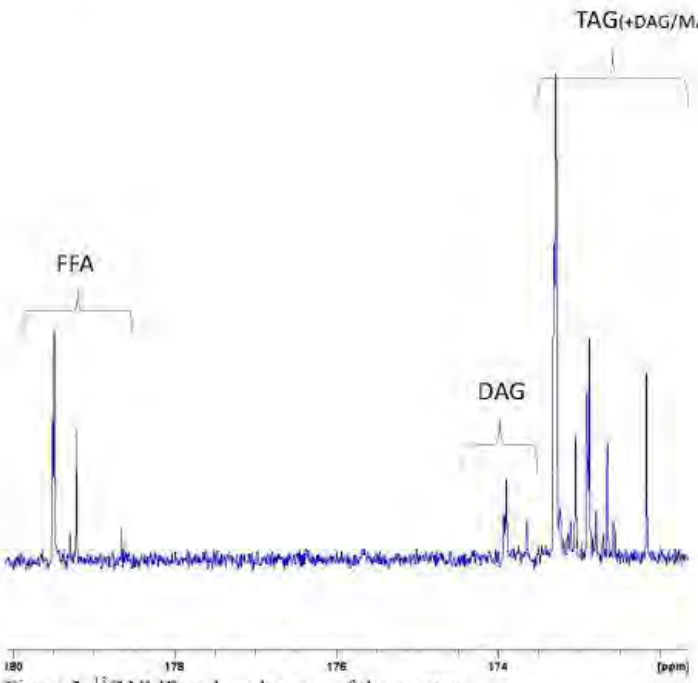

Figure 3. ^{13}C NMR carbonyl region of the spectra.

Free fatty acids (FFA) can be observed in the carbonyl region of the spectra (see Figure 3). The fatty acids as FFA was evaluated by integration of relevant peaks, and calculated to be approximately 13% of total fatty acids (mole%).

The content of FFA in crude cod liver oils varies according the storage conditions of cod livers prior to processing, and the production process. When TAGs are hydrolysed, FFA, DAGs and MAGs are formed. Generally, FFAs are removed from crude oil early in the refining process.The levels of FFA (and DAGs/MAGs) in the present sample are higher than normally observed in refined fish oils. (Omega-3 concentrates may also have relative high levels of DAGs and MAGs, as observed in Aursand et al., 2007, but from the results obtained here, we cannot conclude that concentrates have been added, it seems more likely that the DAGs and MAGs stem from hydrolysis of TAGs in the present oil due to the high FFA levels).

2.2 Oxidation status, from ^{1}H NMR and classical methods

Previous ^{1}H NMR studies have shown that peroxides peaks are most easily observed when deuteriated chloroform is used (CDCL3), while aldehydes peaks are better resolved in a mixture of CDCL3 and dimethyl sulfoxide-d6 (DMSO) (Christina Skiera, 2013 [2]. Therefore, the current sample was analysed both in $CDCL_3$ solvent, and in a mixture of CDCL3 and DMSO (1:5).

The content of oxidation products was below the detection limits in the current NMR experiments (ns= 124 scans), see Figure 4. Additional oxidation analyses in our laboratory, supported the fact that the sample

[redacted]

[redacted]

showed relative low oxidation levels, with PV values of 0.53 (the AV measurement on the sample was not reliable due to interference with the sample, possibly due to pigments or other in the sample).

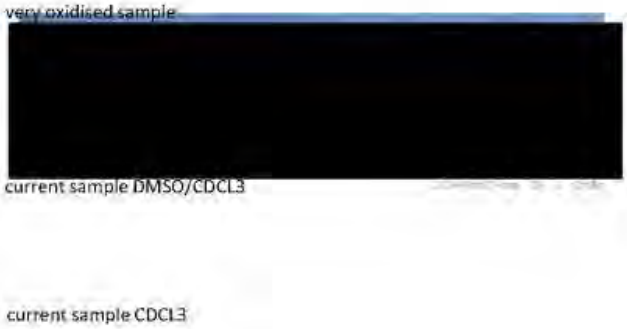

Figure 4. ^{1}H NMR region where oxidation products may be observed. Spectra are shown for : the current sample in CDCL3 (blue), current sample in CDCL3/DMSO , and a very oxidised cod liver oil sample in CDCL3/DMSO (green). Aldehydes and peroxides can be observed between 11- 9 ppm in oxidised sample.

2.3 Antioxidants and impurities

In the ^{1}H NMR spectra, peaks from vitamin A (all-trans-retinol palmitate) could be observed (Figure 5). Cod liver oils are known to be relatively rich in vitamin A.

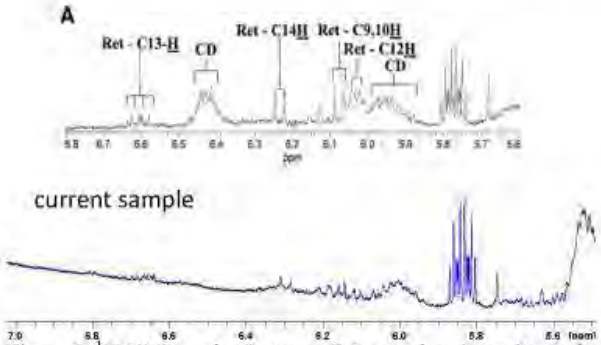

Figure 5. ^{1}H NMR region between 7-6 ppm. low intensity peaks from vitamin A (all-*trans*-retinol palmitate = Ret) could be observed in the current sample. Assignments from Siddiqui et al., 2003* given in **A)**.

[redacted]

[redacted]

2.4 Evaluation of species

The carbonyl region where carbonyl carbons of TAGs (and possibly DAGs/ MAGs) gives signals is shown in Figure 6 for the current sample (blue), and an authentic cod liver oil sample (red). The regiospecific distribution of DHA and EPA, which is characteristic for different fish species, was calculated for the current sample. For DHA the sn-2 position specificity was approximately 82%, and for EPA: 44%. These values of sn-2 position specificity are similar to previous analysed cod liver oils samples. However, when it comes to the sn-2 position specificity of EPA, the value is a bit uncertain due to possible contribution from DAGs and MAGs in this region.

The oveall ^{13}C NMR carbonyl profile are similar to cod liver oil, although the levels of monounsaturated fatty acids in sn-2 position seems to be a bit higher than previously analysed cod liver oils (172.75 ppm) (visual comparison, Figure 6). The sample is more similar to cod liver oil of wild origin than e.g. previous analysed salmon oil or anchovy oil (results not shown). The content of fatty acid C18:2n-6 is lower than previously analysed cod liver oils of farmed cod.

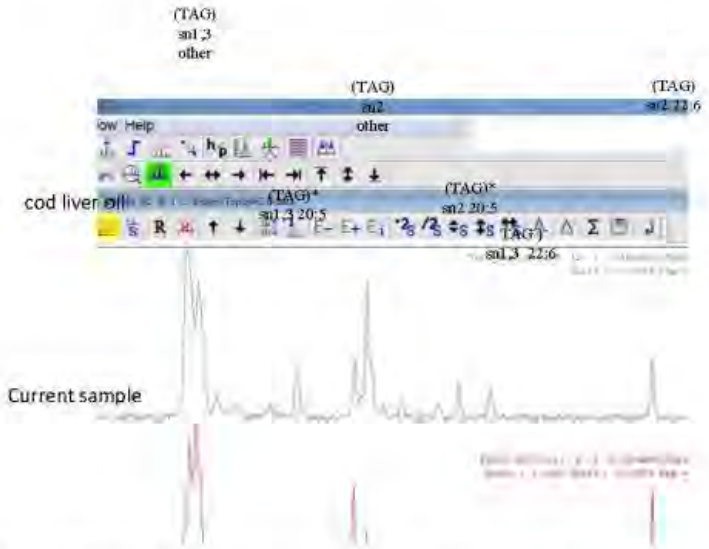

Figure 6. ^{13}C NMR carbonyl region for sn-2 posistion specificities of DHA and EPA. Some peaks are marked with an * due to possible contributions from DAG and MAG in this region for the current sample.

3 Conclusion

The level of oxidation products was found to be low with the methods employed (NMR, and PV analyses). The AV results was not reliable, it is not established what kind of compound in the sample that cause interference with the method.

[redacted]

[redacted]

The levels of FFAs, DAGs and MAGs were relatively high, implying a significant hydrolysis of the TAGs originally present in the raw material.

When it comes to species, the sample resembles previously analysed cod liver oils from wild cod, but due to the great degree of hydrolysis, it cannot be concluded what kind of species the sample consist of, or if it is a mixture of different oils.

4 Literature

Skiera, C. ^{1}H NMR spectroscopic determination of deterioration marker compounds in fats and oils", PhD thesis. 2013.

Siddiqui, N et al., Multicomponent analysis of encapsulated marine oil supplements using high-resolution 1H and 13C NMR techniques. J Lipid Research (40), 2406-2427, 2003.

Aursand et al., 2007. High-Resolution ^{13}C Nuclear magnetic resonance spectroscopy pattern recognition of fish oil capsules. J Agric Food Chem, 55, 38-47, 2007

[redacted]

[redacted]

Sample	Measurement	Menaquinone-4	Menaquinone-5	Phylloquinone	Menaquinone-6	Menaquinone-7	Menaquinone-8	Menaquinone-9	Menaquinone-10
name		ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Cod liver oil	1	13,83	0,00	1,01	3,23	0,00	1,12	1,26	0,00
	2	11,73	0,00	1,02	3,27	0,00	1,16	1,19	0,00

[redacted]

2/2

3-3-2015

[redacted]

Title:

TOTOX, % Free Fatty Acid, TBARS, Fatty Acid, Acid Value, Benzo(a)pyrene, Heavy Metal, Biogenic Amine, Dioxin & PCB Analysis

[redacted]

Date of report: 01st October 2013

[redacted]

Company name:	[redacted]	Date sample received:	16.07.13
Customer contact name:		Date report prepared:	01.10.13
Contract number:		No. of samples:	2
P.O. number:		Sample type:	Cod Liver Oil

Analysis performed:	Peroxide	Date of test: 06.08.13
	Anisidine	Date of test: 25.07.13
	% Free Fatty Acid	Date of test: 23.07.13
	TBars	Date of test: 14.08.13
	Fatty Acid	Date of test: 07.08.13
	Dioxins and PCBs	Date of test: 07.08.13
	Benzo(a)pyrene *	Date of test: 19.07.13
	Vitamin A (Retinol)*	Date of test: 19.07.13
	Vitamin D2*	Date of test: 19.07.13
	Vitamin D3*	Date of test: 19.07.13
	Heavy Metals*	Date of test: 19.07.13
	Biogenic amines*	Date of test: 19.07.13

Methods used:	LM020.R00; LM002.R01; LM021.R00; LM024.R00; LM014.R00; Determination of thiobarbituric acid reactive substances (TBARS); Tests marked as "*" have been subcontracted

[redacted]

Date: 02/10/13

[redacted]

Issue date: 01 October 2013

[redacted]

VITAMIN A (RETINOL) ANALYSIS

SAMPLE ID	VIT A (iu/g Vit A)
Cod Liver Oil B	468

VITAMIN D2 (ERGOCALCIFEROL) ANALYSIS

SAMPLE ID	VIT D2 (iu/g Vit D2)
Cod Liver Oil B	<0.50

VITAMIN D3 (CHOLECALCIFEROL) ANALYSIS

SAMPLE ID	VIT D3 (iu/g Vit D3)
Cod Liver Oil B	47.7

% FREE FATTY ACID ANALYSIS

SAMPLE ID	% FREE FATTY ACID	ACID VALUE
Cod Liver Oil B	40.10	79.80

Above value calculated from analyses performed in duplicate.

TOTOX ANALYSIS

SAMPLE ID	PEROXIDE VALUE	ANISIDINE VALUE	TOTOX
Cod Liver Oil B	2.42	3.44	8.27

Above values calculated from analyses performed in duplicate.

PV expressed as Meq/Kg
AV expressed as anisidine value units

TOTOX = 2PV+AV

[redacted]

Issue date: 01 October 2013

[redacted]

TBAR ANALYSIS

SAMPLE ID	TBARS (mg/kg)
Cod Liver Oil B	23.60

Above value calculated from analyses performed in duplicate.
TBARs are expressed as mg/kg for feeds and oil and nmole/g tissue for flesh or other tissues.

POLYAROMATIC HYDROCARBONS

SAMPLE ID	BENZO(A)PYRENE (µg/kg)
Cod Liver Oil B	<0.2

Above value calculated from analyses performed in duplicate.

HEAVY METAL ANALYSIS

	SAMPLE ID
	Cod Liver Oil B
Cadmium	0.013
Lead	<0.01
Arsenic	4.66
Mercury	<0.01

Above values expressed as mg/kg.

[redacted]

Issue date: 01 October 2013

[redacted]

BIOGENIC AMINE ANALYSIS

	SAMPLE ID
	Cod Liver Oil B
Tryptamine	113
Phenylethylamine	168
Putresine	44.3
Cadaverine	85.5
Histamine	<10.0
Tyramine	177
Spermidine	<10.0
Spermine	<10.0

Above values expressed as mg/kg.

[redacted]

Issue date: 01 October 2013

[redacted]

Fatty acid composition (% total fatty acids and mg FA/g oil) of total lipid from Cod Liver Oil (B)

Fatty acid	%	mgFA/g Oil
14:0	3.75	31.60
15:0	0.25	2.11
16:0	12.92	108.85
18:0	2.72	22.93
20:0	<LOQ	<LOQ
22:0	<LOQ	<LOQ
24:0	<LOQ	<LOQ
Total saturated	19.64	165.49
16:1n-9	0.28	2.39
16:1n-7	9.18	77.36
18:1n-9	21.46	180.81
18:1n-7	8.42	70.97
20:1n-11	3.33	28.07
20:1n-9	1.71	14.41
20:1n-7	0.28	2.34
22:1n-11	2.87	24.22
22:1n-9	0.43	3.62
24:1n-9	0.44	3.72
Total monounsaturated	48.41	407.91
18:2n-6	0.94	7.89
18:3n-6	0.13	1.13
20:2n-6	0.21	1.78
20:3n-6	<LOQ	<LOQ
20:4n-6	0.40	3.40
22:4n-6	<LOQ	<LOQ
22:5n-6	<LOQ	<LOQ
Total n-6 PUFA	1.69	14.20
18:3n-3	0.59	4.97
18:4n-3	2.11	17.77
20:3n-3	0.07	0.62
20:4n-3	0.57	4.82
20:5n-3	16.21	136.59
21:5n-3	0.76	6.38
22:5n-3	0.90	7.59
22:6n-3	7.44	62.66
Total n-3 PUFA	28.65	241.40
16:2	0.77	6.50
16:3	0.43	3.65
16:4	0.42	3.53
	1.62	13.68
Total PUFA	31.96	269.28
Total	100.00	842.68

Limit of Quantification (LOQ) for fatty acid analysis is 0.06%

[redacted]

Issue date: 01 October 2013

[redacted]

Mono-ortho PCBs	CLO (B)	Concentration pg/g oil	WHO-TEF	TEQ pg/g oil	TEQ pg/g oil
PCB-105	233'44-Pe-CB	963.170	0.00003	0.029	0.029
PCB-114	2344'5-Pe-CB	56.221	0.00003	0.002	0.002
PCB-118	23'44'5-Pe-CB	2723.974	0.00003	0.082	0.082
PCB-123	2'344'5-Pe-CB	108.353	0.00003	0.003	0.003
PCB-156	233'44'5-Hx-CB	164.290	0.00003	0.005	0.005
PCB-157	233'44'5'-Hx-CB	60.276	0.00003	0.002	0.002
PCB-167	23'44'55'-Hx-CB	106.230	0.00003	0.003	0.003
PCB-189	233'44'55'-Hp-CB	13.256	0.00003	0.000	0.000
Sum mono-ortho PCB				0.126	0.126
Parameter		Concentration pg/g wet weight	WHO-TEF	TEQ pg/g wet weight	TEQ pg/g wet weight
2378-TCDD		0.099	1.0000	0.0990	0.099
12378-PeCDD		0.130	1.0000	0.1297	0.130
123478-HxCDD		0.184	0.1000	0.0184	0.018
123678-HxCDD		0.237	0.1000	0.0237	0.024
123789-HxCDD		0.116	0.1000	0.0116	0.012
1234678-HpCDD		0.162	0.0100	0.0016	0.002
OCDD		1.062	0.0003	0.0003	0.000
Sum PCDD				0.28	0.28
2378-TCDF		3.125	0.1000	0.3125	0.313
12378-PeCDF		0.326	0.0300	0.0098	0.010
23478-PeCDF		0.125	0.3000	0.0376	0.038
123478-HxCDF		0.052	0.1000	0.0052	0.005
123678-HxCDF		0.086	0.1000	0.0086	0.009
234678-HxCDF		0.123	0.1000	0.0123	0.012
123789-HxCDF		0.023	0.1000	0.0023	0.002
1234678-HpCDF		0.072	0.0100	0.0007	0.001
1234789-HpCDF		0.069	0.0100	0.0007	0.001
OCDF		0.262	0.0003	0.0001	0.000
Sum PCDF				0.39	0.39
PCB 77	33',44'-TeCB	96.390	0.0001	0.0096	0.010
PCB 81	344',5-TeCB	6.510	0.0003	0.0020	0.002
PCB 126	33',44',5-PeCB	13.579	0.1000	1.3579	1.358
PCB 169	33',44',55'-HxCB	5.766	0.0300	0.1730	0.173
Sum non-ortho PCB				1.54	1.54
				Lower	Upper
pg dl-like PCBs WHO-TEQ/g				1.67	1.67
pg PCDD/Fs WHO-TEQ/g				0.67	0.67
total pg WHO-TEQ/g				2.34	2.34

Limit of quantification (LOQ)
Limit of detection (LOD)
Not detected (ND)

[redacted]

Issue date: 01 October 2013

[redacted]

Mono-ortho PCBs	Ref CLO PT	Concentration pg/g oil	WHO-TEF	TEQ pg/g oil	Concensus PT
PCB-105	233'44-Pe-CB	4521.339	0.00003	0.136	0.140
PCB-114	2344'5-Pe-CB	239.163	0.00003	0.007	0.009
PCB-118	23'44'5-Pe-CB	12041.628	0.00003	0.361	0.410
PCB-123	2'344'5-Pe-CB	329.074	0.00003	0.010	0.006
PCB-156	233'44'5-Hx-CB	1501.546	0.00003	0.045	0.044
PCB-157	233'44'5'-Hx-CB	568.483	0.00003	0.017	0.013
PCB-167	23'44'55'-Hx-CB	904.227	0.00003	0.027	0.025
PCB-189	233'44'55'-Hp-CB	89.315	0.00003	0.003	0.004
Sum mono-ortho PCB				0.606	0.651
Parameter		Concentration pg/g wet weight	WHO-TEF	TEQ pg/g wet weight	TEQ pg/g wet weight
2378-TCDD		0.103	1.0000	0.1029	0.310
12378-PeCDD		0.079	1.0000	0.0789	0.110
123478-HxCDD		0.118	0.1000	0.0118	0.004
123678-HxCDD		0.228	0.1000	0.0228	0.033
123789-HxCDD		0.105	0.1000	0.0105	0.008
1234678-HpCDD		0.191	0.0100	0.0019	0.002
OCDD		0.371	0.0003	0.0001	0.000
Sum PCDD				0.23	0.47
2378-TCDF		6.670	0.1000	0.6670	0.650
12378-PeCDF		0.631	0.0300	0.0189	0.032
23478-PeCDF		0.446	0.3000	0.1339	0.210
123478-HxCDF		0.211	0.1000	0.0211	0.020
123678-HxCDF		0.226	0.1000	0.0226	0.038
234678-HxCDF		0.265	0.1000	0.0265	0.035
123789-HxCDF		0.043	0.1000	0.0043	0.003
1234678-HpCDF		0.059	0.0100	0.0006	0.002
1234789-HpCDF		0.021	0.0100	0.0002	0.001
OCDF		0.509	0.0003	0.0002	0.000
Sum PCDF				0.90	0.99
PCB 77	33',44'-TeCB	66.644	0.0001	0.0067	0.009
PCB 81	344',5-TeCB	6.139	0.0003	0.0018	0.001
PCB 126	33',44',5-PeCB	69.772	0.1000	6.9772	7.000
PCB 169	33',44',55'-HxCB	22.440	0.0300	0.6732	0.420
Sum non-ortho PCB				7.66	7.43
				Lower	Upper
pg dl-like PCBs WHO-TEQ/g				8.26	8.08
pg PCDD/Fs WHO-TEQ/g				1.12	1.46
total pg WHO-TEQ/g				9.39	9.54
Limit of quantification (LOQ) Limit of detection (LOD) Not detected (ND)					

[redacted]

Issue date: 01 October 2013

[redacted]

Sample Description: Butter Oil
Client Sample Code: Lot# 21745
PO Number:
Client Code: QD0006244

Entry Date: 02/17/2015
Reporting Date: 03/10/2015

The Whole Nutritionist
attn: PhD Kaayla T. Daniel
412 Dartmouth Drive SE
Albuquerque, NM 87106

The Whole Nutritionist
Attn: PhD Kaayla T. Daniel
412 Dartmouth Drive SE
Albuquerque, NM 87106

CERTIFICATE OF ANALYSIS

AR-15-QD-028340-01

Test	Result	
QD058 - Copper by ICP		**Completed: 02/24/2015**
AOAC 965.17 / 985.01 mod.		
* Copper	<1.0 ppm	
QD107 - Iron by ICP		**Completed: 02/24/2015**
AOAC 965.17 / 985.01 mod.		
* Iron	0.0003 %	
QD06T - Cadmium (Mwd-ICP-MS)		**Completed: 02/25/2015**
J. AOAC vol. 90 (2007) 844-856 (Mod)		
* Cadmium (Cd)	<0.010 mg/kg	
QD06S - Lead (Mwd-ICP-MS)		**Completed: 02/25/2015**
J. AOAC vol. 90 (2007) 844-856 (Mod)		
* Lead (Pb)	<0.010 mg/kg	
QD06R - Mercury (Mwd-ICP- MS)		**Completed: 02/25/2015**
J. AOAC vol. 90 (2007) 844-856 (Mod)		
* Mercury (Hg)	<0.010 mg/kg	
QD06Q - Arsenic (Mwd-ICP-MS)		**Completed: 02/25/2015**
J. AOAC vol. 90 (2007) 844-856 (Mod)		
* Arsenic (As)	<0.010 mg/kg	
QQ182 - Total Vitamin A		**Completed: 02/25/2015**
AOAC 974.29 Mod.		
* ß-carotene	389 IU/100 g	
* Retinol	1,310 IU/100 g	
* Total Vitamin A	1,700 IU/100 g	
QQ188 - Vitamin E-Tocopherol Profile (AOAC, Most Matrices)		**Completed: 02/26/2015**
AOAC 971.30 with HPLC quantification mod.		
* Alpha-Tocopherol	2.32 mg/100 g	
* Beta-Tocopherol	<0.1 mg/100 g	
* Gamma-Tocopherol	<0.1 mg/100 g	
* Delta-Tocopherol	<0.1 mg/100 g	
* Total Vitamin E (Tocopherols)	2.32 mg/100 g	
QD094 - Free Fatty Acids (FFA)		**Completed: 02/23/2015**
AOCS Ca 5a-40		
* FFA (Free Fatty Acids)	1.5 %	
QD005 - Acid Value		**Completed: 02/23/2015**
AOCS Cd 3d-63		

[redacted]

[redacted]

AR-15-QD-028340-01

Client Sample Code: Lot# 21745

Test	Result	
QD005 - Acid Value		**Completed: 02/23/2015**
AOCS Cd 3d-63		
* Acid value	3.0 mg KOH/g	
QD103 - Peroxide Value (PV)		**Completed: 02/23/2015**
AOCS Cd 8-53		
* Peroxide Value - Initial	3.6 meq/kg	
QD01P - p-Anisidine Value		**Completed: 02/23/2015**
AOCS Cd 18-90		
* p-Anisidine value	4.1	
QD222 - TBA Value		**Completed: 02/26/2015**
AOCS Cd 19-90		
TBA value	0.0066	
UMJVV - Lactic acid bacteria - CMMEF Chapter 19.571		**Completed: 02/23/2015**
CMMEF Chapter 19.571		
Lactic acid bacteria	< 10 (est) cfu/g	
QA01S - Fluoroquinolones and Quinolones (LC-MSMS)		**Completed: 03/03/2015**
FDA LIB 4383		
Cinoxacin	< 10 µg/kg	
Ciprofloxacin	< 5.0 µg/kg	
Danofloxacin	< 5.0 µg/kg	
Difloxacin	< 10 µg/kg	
Enoxacin	< 10 µg/kg	
Enrofloxacin	< 5.0 µg/kg	
Flumequin	< 10 µg/kg	
Lomefloxacin	< 10 µg/kg	
Marbofloxacin	< 5.0 µg/kg	
Nalidixic acid	< 10 µg/kg	
Norfloxacin	< 5.0 µg/kg	
Ofloxacin	< 10 µg/kg	
Oxolinic acid	< 10 µg/kg	
Sarafloxacin	< 5.0 µg/kg	
KK00A - Coenzyme Q10, Oxidative Preparation (HPLC)		**Completed: 03/10/2015**
Internal Method		
Coenzyme Q10	<0.005 %	
DJ700 - Biogenic Amines (dansyl)		**Completed: 02/27/2015**
Czech J. Food Sci. Vol.21		
2-Phenylethylamine	< 1 (LOQ) mg/kg	
Spermine	< 1 (LOQ) mg/kg	
Cadaverine	< 1 (LOQ) mg/kg	
Histamine	< 1 (LOQ) mg/kg	
Putrescine	< 1 (LOQ) mg/kg	
Spermidine	< 1 (LOQ) mg/kg	
Tryptamine	< 5 (LOQ) mg/kg	
Tyramine	< 1 (LOQ) mg/kg	

**The test result is covered by our current A2LA accreditation*

[redacted]

[redacted]

Sender:

Samples from:

The Whole Nutritionist
Att: Kaayla Daniel
412 Dartmouth Dr SE, Albuquerque, NM
87106
USA

Sample code:	090215-TheWholeNutritionist-oil
Data analyzed:	03/03/2015
Date run HPLC:	11/02/2015 till 02/03/2015
HPLC:	

Samples:

Sort of samples (pills, powder, oil, food product etc.) :	oil
Amount of samples:	2
Description sample(s):	cod liver oil and butter milk oil
Samples reported to be……. µg/ng/ per pill/ gram etc.	unknown
Samples analyzed in singular/ duplicate/ triplicate:	duplicate

Comments:

……
……
……
……

1/2

3-3-2015

[redacted]

Sample	Measurement	Menaquinone-4	Menaquinone-5	Phylloquinone	Menaquinone-6	Menaquinone-7	Menaquinone-8	Menaquinone-9	Menaquinone-10
name		ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
[redacted]									
Butter milk oil	1	393,84	0,00	146,21	0,00	0,00	0,00	0,00	0,00
	2	431,11	0,00	154,83	0,00	0,00	0,00	0,00	0,00

3-3-2015

[redacted]

Results:

Sample name	Measurement	Menaquinone-4 ng/g	Menaquinone-5 ng/g	Phylloquinone ng/g	Menaquinone-6 ng/g	Menaquinone-7 ng/g	Menaquinone-8 ng/g	Menaquinone-9 ng/g	Menaquinone-10 ng/g
1 Butter oil	1	250,65	0,00	94,35	0,00	0,00	0,00	0,00	0,00
	2	259,89	0,00	97,61	0,00	0,00	0,00	0,00	0,00
2 Ghee	1	335,70	0,00	89,77	0,00	0,00	0,00	0,00	0,00
	2	324,36	0,00	87,91	0,00	0,00	0,00	0,00	0,00

11-8-2015 2/2

ACKNOWLEDGMENTS

This was a top secret project. I am grateful to many people who helped with this investigation, most of whom spoke to me on the condition that I keep their names private. These included top university professors, scientists, researchers, lab managers, doctors and other health care practitioners.

Many thanks to the Price-Pottenger Nutrition Foundation, which opened its archives to me. Former aerospace engineer Sarah Smith, of the Nourished and Nurtured blog, provided thoughtful feedback and valuable editorial assistance. I particularly want to thank Dr. Ron Schmid ND for his generosity and integrity. He and several other loyal members of the Weston A. Price Foundation helped fund my laboratory testing. All of them trusted me to get to the truth, and fully accepted my condition that I would allow no control over the content and would publish the results of the investigation no matter what.

Finally, I would never have had the courage to complete this project without the inspiring example of my friend and mentor the late Mary G. Enig, PhD.

* * * * *

ABOUT THE AUTHOR

Kaayla T. Daniel, PhD, is known as **The Naughty Nutritionist®** because she tells the truth that's too hot to handle! She is Vice President of the Weston A. Price Foundation and on the Board of Directors of the Farm-to-Consumer Legal Defense Fund.

In 2005, she received the Weston A. Price Foundation's Integrity in Science Award.

Dr. Daniel earned her PhD in Nutritional Sciences from the Union Institute and University in Cincinnati and was certified as a clinical nutritionist (CCN) by the International and American Association of Clinical Nutritionists in Dallas.

Dr. Daniel is coauthor (with Sally Fallon Morell) of *Nourishing Broth: An Old-Fashioned Remedy for the Modern World* (2014) and the author of *The Whole Soy Story: The Dark Side of America's Favorite Health Food* (2005). She has been a guest on *The Dr. Oz Show,* PBS *Healing Quest,* NPR's *People's Pharmacy,* ABC's *View from the Bay,* and Discovery Channel's *Medical Hotseat*, and has shared the stage with Dr. Mark Hyman, JJ Virgin, Chris Kresser, Gary Taubes, Charles Poliquin, Dr. Joseph Mercola, Joel Salatin, Dr. Terry Wahls, David Wolfe and other prominent health experts. Dr Daniel has also spoken at numerous professional conferences, including Ancestral Health, Paleo f(x) BoulderFest, Wise Traditions, National Association of Nutritional Professionals (NANP), Nutritional Therapy Association (NTA) and Bio-Signature.

Subscribe to Kaayla's *Naughty Edge* newsletter and get her free eBook *Fats of Life* at drkaayladaniel.com.
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