United States Court of Appeals for the Federal Circuit

SOFT GEL TECHNOLOGIES, INC.,
Appellant

v.

JARROW FORMULAS, INC.,
Appellee

2016-1814

Appeal from the United States Patent and Trademark Office, Patent Trial and Appeal Board in No. 95/002,396.

SOFT GEL TECHNOLOGIES, INC.,
Appellant

v.

JARROW FORMULAS, INC.,
Appellee

2016-1815

Appeal from the United States Patent and Trademark Office, Patent Trial and Appeal Board in No. 95/002,405.

SOFT GEL TECHNOLOGIES, INC.,
Appellant

v.

JARROW FORMULAS, INC.,
Appellee

2017-1051

Appeal from the United States Patent and Trademark Office, Patent Trial and Appeal Board in No. 95/002,411.

Decided: July 26, 2017

DEVAN V. PADMANABHAN, Winthrop & Weinstine, PA, Minneapolis, MN, argued for appellant. Also represented by SRI SANKARAN, ERIN DUNGAN, BRETT KLEIN.

MARK D. GIARRATANA, McCarter & English, LLP, Hartford, CT, argued for appellee. Also represented by ERIC E. GRONDAHL, CHARLES D. RAY.

Before PROST, *Chief Judge,* BRYSON and HUGHES, *Circuit Judges.*

BRYSON, *Circuit Judge.*

Soft Gel Technologies, Inc., appeals from three *inter partes* reexamination decisions of the Patent Trial and Appeal Board. The Board's decisions invalidated numer-

ous claims in each of three related Soft Gel patents for obviousness. We affirm.

I

A

Soft Gel is the named assignee of U.S. Patent Nos. 8,124,072 ("the '072 patent"), 8,105,583 ("the '583 patent"), and 8,147,826 ("the '826 patent"). The '583 patent issued from a continuation-in-part, and '826 patent issued from a continuation, of the '072 patent. The '072 patent issued on February 28, 2012; the '583 patent issued on January 31, 2012; and the '826 patent issued on April 3, 2012.

The specifications of the three patents describe a method for dissolving a substance commonly referred to as CoQ10 in solvents known as monoterpenes. '072 patent, col. 2, ll. 46-48.[1] The patented inventions include a composition, a soft gelatin capsule, and a method of making such a soft gelatin capsule, each involving a solution of CoQ10 dissolved in a monoterpene.

CoQ10, also known as ubiquinone, is a coenzyme, i.e., a chemical compound that is required for the biological activity of certain proteins. '072 patent, col. 1, ll. 16-25. It "affects the function of almost all cells in the body, making it essential for the health of all human tissues and organs." *Id.*, col. 1, ll. 39-41.

CoQ10 is necessary for certain metabolic processes and for the production of cellular energy; it has a secondary role as an antioxidant. '072 patent, col. 1, ll. 18-24, 37-38. It is particularly important in "the cells that are the most metabolically active: heart, immune system, gingiva, and gastric mucosa." *Id.*, col. 1, ll. 22-24, 41-43.

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[1] The '826 and '583 patents include the written description of the '072 patent in its entirety.

In clinical trials, CoQ10 has been shown to be effective in regulating blood pressure and cholesterol levels, improving cardiovascular health, and "thwarting various diseases such as certain types of cancers." *Id.*, col. 1, ll. 44-49; *see also id.*, col. 7, ll. 11-21 (noting that CoQ10 has been used in the treatment of cardiovascular conditions, periodontal diseases, mitochondrial-related diseases and disorders, and neurological disorders).

Although CoQ10 is synthesized by the body, the body may require more than it can synthesize or obtain through normal dietary intake. '072 patent, col. 1, ll. 26-28. Oral supplementation can compensate for a CoQ10 deficiency. *Id.*, col. 1, ll. 29-31.

Unfortunately, CoQ10 is "sparingly soluble in hydrophilic solvents such as water." '072 patent, col. 1, ll. 51-52. According to the Soft Gel patents, at the time of the inventions most solvents that were used to administer CoQ10 in liquid form could dissolve, at most, only about 5 to 10 percent of the CoQ10. *Id.*, col. 1, ll. 64-67; *id.*, col. 2, ll. 59-61. For that reason, CoQ10 was generally administered in solid form, such as in a tablet or powder. *Id.*, col. 1, ll. 52-53; *id.*, col. 2, ll. 63-64. CoQ10 could also be administered as a suspension, in which the CoQ10 is partially dissolved in a solvent. *Id.*, col. 1, ll. 52-53; *id.*, col. 3, ll. 21-23. But those delivery methods limited the bioavailability of the CoQ10, as only a small fraction of the CoQ10 would enter the bloodstream. *Id.*, col. 1, ll. 53-55; *id.*, col. 3, ll. 23-24. The Soft Gel patents state that there was "a need in the art for an improved methodology to deliver increased amount[s] of bioavailable CoQ-10 to an individual in need thereof." *Id.*, col. 1, ll. 56-58.

The patents describe the discovery of monoterpenes as a solvent for CoQ10. '072 patent, col. 1, ll. 62-64; *id.*, col. 2, ll. 46-48; *see also id.*, col. 3, ll. 24-26. Monoterpenes are a class of compounds that have a ten-carbon skeleton and consist of "two isoprene units connected in a head-to-end

manner." *Id.*, col. 3, ll. 31-34. "Suitable examples of monoterpenes include, but are not limited to, limonene, . . . carvone, . . . and derivatives thereof." *Id.*, col. 3, ll. 49-53; *see also id.*, col. 3, ll. 59-63 (listing, "[i]n particular," a number of "suitable limonene derivatives").

Unlike aqueous solvents, monoterpenes can dissolve significant amounts of CoQ10. "Generally, about 30 to about 45% of the CoQ-10 (by weight [relative to that of the monoterpene]) is solubilized [dissolved] in the monoterpene." '072 patent, col. 2, ll. 11-12; *see also, e.g.*, *id.*, col. 2, line 65, through col. 3, line 11 (noting that up to about 60% by weight of CoQ10 may be dissolved in monoterpene, and describing other "aspects" of the invention in which the weight of solubilized CoQ10 relative to monoterpene is "about 0.1 percent . . . to about 45 percent," "about 5 to about 50 percent," "about 15 to about 40 percent," and "about 20 to about 35 percent"). The solution of CoQ10 dissolved in monoterpene may then be formulated as a caplet or soft gelatin capsule containing the solution. *Id.*, col. 3, line 64, through col. 4, line 1. Formulations of that solution of CoQ10 dissolved in a monoterpene "provid[e] increased bioavailability in delivery," *id.*, col. 1, ll. 10-12, because "the solvated [dissolved] coenzyme can more easily pass into cells[,] . . . delivering increased amounts of the coenzyme into an individual's physiological makeup," '583 patent, col. 7, ll. 4-7.

The claims of the Soft Gel patents focus on solutions of CoQ10 and a monoterpene called limonene. Limonene is a compound that can have one of two different three-dimensional physical structures, labeled d-limonene and l-limonene. The claims of the three Soft Gel patents were amended to cover only solutions of CoQ10 and d-limonene.

Claim 1 of each patent is representative for purposes of the respective appeal.

Claim 1 of the '072 patent, as amended, recites as follows:

> 1. A soft gelatin capsule, comprising coenzyme Q-10 solubilized in a sufficient quantity of d-limonene suitable to solubilize said coenzyme Q-10 to form a solution, wherein the amount of coenzyme Q-10 in said solution is about 15 percent up to about 60 percent coenzyme Q-10 by weight, with the proviso that the coenzyme Q-10 solubilized in the d-limonene is not in an emulsion, suspension, or elixir.

Claim 1 of the '583 patent, as amended, recites as follows:

> 1. A solubilized coenzyme Q-10 composition comprising:
>
> coenzyme Q-10;
>
> a sufficient quantity of d-limonene suitable to solubilize said coenzyme Q-10 thereby providing a solution in which the coenzyme Q-10 remains solubilized, with the proviso that said solution is not part of an emulsion, suspension, or elixir.

Claim 1 of the '826 patent, as amended, recites as follows:

> 1. A method of preparing a soft gel capsule, comprising the steps of:
>
> (a) mixing coenzyme Q-10 with a sufficient quantity of d-limonene suitable to dissolve said coenzyme Q-10 and form a solution, with the proviso that said solution is not part of an emulsion, suspension, or elixir; wherein the amount of coenzyme Q-10 in said solution is about 15% up to about 60% coenzyme Q-10 by weight;

(b) mixing said solution with an acceptable carrier to form a composition, with the proviso that said composition is not an emulsion, suspension, or elixir; and

(c) encapsulating said composition in a soft gel capsule.

B

Jarrow Formulas, Inc., requested *inter partes* reexaminations of the three Soft Gel patents on September 15, 2012. The Board ordered reexaminations of all three patents on November 23, 2012. In each reexamination, the examiner rejected various claims of the patents.

On appeal, the Board considered five key references. The first, Patent Application Laid-Open Disclosure No. S57-42616 ("Motoyama"), was published on March 10, 1982. The Motoyama reference claims an oral formulation containing CoQ10 dissolved in an oil. Motoyama at 1, 11. The oil is defined as "an oil-fat, lipid, wax, refined oil, mineral oil, or mixture of such oils," and includes "terpenes" among the examples of such oils. *Id.* at 1, 5. Motoyama describes the method of dissolving CoQ10 in the oil and encapsulating that solution. *Id.* at 4-5.

Motoyama discloses that CoQ10 is "highly soluble" in a particular monoterpene known as carvone. Motoyama at 2; *see also id.* at 5 ("[C]arvone is a particularly preferred oil due to good solubility for [CoQ10] and the property of dissolving an equal weight of [CoQ10] at room temperature."). One of the two forms of carvone, l-carvone, is found in spearmint oil and peppermint oil. *Id.* at 2. Spearmint and peppermint oils are essential oils, i.e., oils derived from plants. *Id.* at 5.

Motoyama describes several examples in which CoQ10 was dissolved in l-carvone, after which the formulation was placed in capsules. Motoyama at 5-7. The capsules were orally administered to beagle dogs, and the

resulting concentration of CoQ10 in the dogs' blood was measured. *Id.* at 6. The observed effect of the CoQ10 formulation was the "high bioavailability [of CoQ10] and particularly good absorption in the digestive tract, and . . . a large area under the curve (AUC) of concentration [of CoQ10] in the blood." *Id.* at 2; *see also id.* at 6-7 (Tables 1-2).

The next two references have overlapping disclosures; the first is a patent, and the second is a dissertation on which that patent is based. The patent, U.S. Patent No. 7,588,786 ("Khan '786 patent"), was issued in September 2009 to Khan and Nazzal. It claims priority to a provisional application filed in November 2001. The dissertation, authored by Nazzal, is dated August 2002 ("Nazzal").

Both references note the poor solubility of CoQ10 in aqueous solvents such as water, and both posit that solvents such as lipids or oils could be used instead. *See* Nazzal at x; Khan '786 patent, col. 1, ll. 21-26. The idea was to make an oil mixture consisting of oil and CoQ10, and then introduce the oil mixture into the body, where it would encounter an aqueous environment. *See* Nazzal at 17-19; Khan '786 patent, col. 1, ll. 28-30. Although oil does not dissolve in water, Nazzal noted that substances known as emulsifiers could be included in the oil mixture. Nazzal at 19-22. The emulsifiers would allow the oil mixture to disperse in the body as small droplets of oil in the body's aqueous fluids. *Id.*; *see also* Khan '786 patent, col. 1, ll. 28-30. The dispersion of oil droplets in water is called an emulsion—or a micro- or nano-emulsion, depending on the size of the oil droplets in the water. *See* Nazzal at 16-17; Khan '786 patent, col. 1, ll. 26-30. The formulation of CoQ10, oil, and emulsifiers is referred to as a self-emulsifying drug delivery system ("SEDDS"), a self-microemulsifying drug delivery system ("SMEDDS"), or a self-nanoemulsifying drug delivery system ("SNEDDS"). The distinction among the three systems depends on the size of the oil droplets formed when the oil mixture is

introduced into water. Nazzal at 19; Khan '786 patent, col. 1, ll. 26-30; *id.*, col. 2, ll. 52-55.

For the oil mixture, Nazzal and Khan tested CoQ10 with various essential (volatile) oils, including peppermint oil, spearmint oil, and lemon oil, as solvents. *See* Nazzal at 13-14, 115-18; Khan '786 patent, col. 4, ll. 28-31 & Fig. 4. The goal was to obtain an oil mixture in which the CoQ10 was completely melted at 37°C, the average human body temperature. Nazzal at 112; Khan '786 patent, col. 6, line 65, through col. 7, line 2. That would avoid the problem of administering a capsule containing CoQ10 as a suspension (a solid precipitate in the oil), which is not an effective delivery method. Nazzal at 112; *see also* Khan '786 patent, col. 1, ll. 59-62. Instead, after ingestion of the capsule and exposure to body temperatures, the CoQ10 would melt in the oil, facilitating absorption by the body. *See* Nazzal at 26, 112; Khan '786 patent, col. 2, ll. 55-61.

Pure CoQ10 has a melting temperature of 51°C, far above body temperature. Khan '786 patent, col. 6, ll. 13-15 & Fig. 1. But the Khan '786 patent and Nazzal disclose that CoQ10 can be mixed with a sufficient amount of an essential oil to lower its melting temperature. *See* Nazzal at 116-18 (Figs. 4.9-11); Khan '786 patent, col. 6, ll. 36-40 & Figs. 3-4. Khan and Nazzal further disclose that when mixed with an essential oil, the CoQ10 would melt at a lower temperature even after adding an emulsifier to prepare the SNEDDS. *See* Nazzal at 121-23; Khan '786 patent, col. 7, ll. 48-51 & tbl.2.

The Nazzal dissertation concludes with a list of six "[r]ecommendations for future studies." Nazzal at 246. The second and third recommendations on the list are to study "[t]he exact nature of the interaction that exists between CoQ[10] and essential oils" in lowering the melting point of CoQ10, and to study the "[c]hemical components of essential oils such as limonene, menthone,

and carvone . . . for their potency in" lowering the melting point of CoQ10. *Id.*

The fourth reference relied on by the Board was 1 Giovanni Fenaroli, *Fenaroli's Handbook of Flavor Ingredients* 389 (2d ed. 1975) ("Fenaroli"). That reference notes that lemon essential oil has many different components, but "contains approximately 90% limonene (by weight)."

The fifth reference cited by the Board is a monograph published by the World Health Organization's International Agency for Research on Cancer ("IARC"). 56 IARC, *Some Naturally Occurring Substances: Food Items and Constituents, Heterocyclic Aromatic Amines and Mycotoxins* (1993). The monograph states that limonene is "the most frequently occurring natural monoterpene." *Id.* at 135. The monograph further explains that limonene occurs naturally in the d- and l- forms, and that "the *d* form comprises 98-100% of the limonene in most citrus oils." *Id.*

In each of the three decisions at issue in this case, the Board found that (1) Motoyama teaches dissolving CoQ10 in carvone, a monoterpene found in spearmint oil and peppermint oil, and then encapsulating the solution; (2) the Khan '786 patent and Nazzal teach the use of essential oils, including peppermint oil, spearmint oil, and lemon oil, in conjunction with CoQ10; and (3) IARC and Fenaroli teach that d-limonene (a monoterpene) is the main constituent of lemon oil.[2] The Board determined

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[2] In the decisions addressing the '072 and '583 patents, the Board found that d-limonene was "the main constituent" of lemon oil. In the decision on rehearing regarding the '826 patent, the Board found that d-limonene was "one of the main constituents" of lemon oil. That discrepancy is not material to resolution of the

that the combination of those references suggests the invention claimed in the Soft Gel patents—i.e., using d-limonene, as Motoyama had used carvone, to dissolve CoQ10 for oral formulations. The Board also found that a person of skill in the art would have been motivated to combine those references and would have had a reasonable expectation of success in doing so. Ultimately, the Board invalidated, on obviousness grounds, claims 1-24 of the '072 patent; claims 1-2, 4, 6-10, 12-13, and 15-17 of the '583 patent; and claims 1-2, 5, 7, and 6-15 of the '826 patent.[3]

On appeal, Soft Gel challenges as erroneous the Board's factual findings (1) that d-limonene is the main constituent of lemon oil, (2) that the Khan '786 patent does not teach away from the claimed invention, and (3) that a person of ordinary skill would have had a reasonable expectation of success regarding the combination.

II

The question whether a patent claim is invalid for obviousness under 35 U.S.C. § 103(a) requires consideration of the scope and content of the prior art, differences

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appeals, and Soft Gel does not argue that it is. Soft Gel contends that the Board's factual findings that d-limonene is "the main constituent" of lemon oil and that it is "one of the main constituents" of lemon oil are both erroneous.

[3] The Board also found the same sets of claims in the '072 patent and the '583 patent invalid on other grounds, including anticipation and obviousness based on different references. Because we affirm the Board's obviousness ruling based on Motoyama combined with the other four references, which the Board applied in all three decisions, we do not address the other grounds on which the Board upheld the examiner's rejections.

between the prior art and the patent claim, the level of ordinary skill in the art, and any relevant secondary considerations. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). An obviousness determination also requires a person of skill in the art at the time of the invention to have had "an apparent reason to combine the known elements in the fashion claimed by the patent at issue," *id.* at 418, and a "reasonable expectation of success" in doing so, *Alza Corp. v. Mylan Labs., Inc.*, 464 F.3d 1286, 1289 (Fed. Cir. 2006).

1. Soft Gel first challenges the Board's factual finding that d-limonene is the main constituent of lemon oil. The Board relied on the IARC and Fenaroli references, which together show that lemon oil consists of approximately 88 to 90 percent d-limonene by weight. Those references support the Board's finding that d-limonene is the main constituent of lemon oil.

Soft Gel points to another reference that tested the essential oil from a number of different lemon oil species and disclosed one sample in which the limonene content was only 38.1 percent. Lota et al., *Volatile Components of Peel and Leaf Oils of Lemon and Lime Species*, 50 J. Agric. & Food Chem. 796, 797 (2002). Despite that sample, the Lota reference supports the Board's finding. Of the 19 samples tested in Lota, the limonene content ranged from a minimum of 38.1 percent to a maximum of 95.8 percent. *Id.* In 17 of the samples, limonene made up more than half of the sample. *Id.* In the remaining samples, including the one that Soft Gel highlights, the amount of limonene was still much greater than that of any other constituent in the sample. *Id.* (no other constituent made up more than 32 percent of any sample). Based on that evidence, Lota concluded that "[l]imonene was always the main constituent . . . of all oil[]" samples. *Id.* at 799.

According to the IARC reference, the limonene in lemon oil consists entirely, or almost entirely, of d-limonene. IARC at 135 (d-limonene constitutes 98-100% of the limonene in citrus oils). Therefore, Lota and the IARC reference support the Board's finding that d-limonene is the main constituent in the lemon peel oil tested in Lota.

2. Soft Gel next argues that, for several reasons, the Khan '786 patent teaches away from dissolving CoQ10 in lemon oil. The Board rejected that contention. We sustain the Board's ruling.

First, Soft Gel contends that the Khan '786 patent teaches that it is difficult to dissolve CoQ10 in lemon oil. But what the Khan '786 patent states is that CoQ10 is difficult to dissolve in aqueous solvents, fixed (nonvolatile) oils, and triglycerides. Khan '786 patent, col. 1, ll. 46-47, 55-62; *id.*, col. 6, ll. 57-60. Instead of suggesting the use of those types of solvents with CoQ10, the Khan '786 patent teaches the use of an essential (volatile) oil, such as lemon oil, peppermint oil, or spearmint oil, as a solvent for CoQ10. *Id.*, col. 5, ll. 60-61; *id.*, col. 6, ll. 27-31; *see also id.*, col. 6, ll. 43-45. The Khan '786 patent merely notes the difficulty of dissolving CoQ10 in many solvents other than essential oils such as lemon oil.

Second, Soft Gel argues that the Khan '786 patent discloses only the melting of CoQ10 to convert it from a solid to a liquid in the presence of an essential oil. Soft Gel argues that Khan does not disclose dissolving CoQ10 in the oil. That point of contention is immaterial. Regardless of whether the Khan '786 patent is interpreted to disclose dissolving CoQ10 in an essential oil such as lemon oil, the Khan '786 patent does not teach away from the inventions. In fact, the Khan '786 patent teaches the use of essential oils to make CoQ10 more available to the body, which is precisely what is claimed in Soft Gel's patents.

Third, Soft Gel attempts to draw a contrast between lemon oil, on the one hand, and peppermint oil and spearmint oil, on the other. Soft Gel points to an experiment in which the emulsifier Cremophor EL was added to the melted mixture of CoQ10 and an essential oil. Khan '786 patent, col. 6, ll. 43-50. Upon addition of the emulsifier, the CoQ10 would crystallize (solidify) because CoQ10 is not particularly soluble in that emulsifier. *Id.*, col. 6, ll. 36-38. To determine what would happen to the mixture of CoQ10, the essential oil, and the emulsifier upon ingestion, the mixture was heated to 37ºC (body temperature). *Id.*, col. 6, ll. 52-54. At low concentrations of the emulsifier, the CoQ10 melted again, resulting in a liquid mixture. *See id.*, col. 7, tbl.2. That occurred for all four tested essential oils. *See id.* But at higher emulsifier concentrations in the other oils (spearmint, peppermint, and anise), the CoQ10 remained in solid form, even after heating to 37ºC. *See id.* With lemon oil, the CoQ10 re-melted, even at high emulsifier concentrations. *Id.*, col. 7, ll. 42-44 & tbl.2. Those results show that lemon oil provided the best performance among the essential oils, not that it behaved in an entirely different manner from the other oils. *See id.*, col. 7, ll. 48-49 ("The use of lemon oil appears reasonable and attractive.").

For those reasons, Soft Gel has failed to discredit the Board's finding that the Khan '786 patent does not teach away from the inventions of the Soft Gel patents. More importantly, Soft Gel's focused attack on the Khan '786 patent does not undermine the Board's decision, which is based on a combination of references. *See In re Merck & Co.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986) (in the context of teaching away, "[n]on-obviousness cannot be established by attacking references individually where the rejection is based upon the teachings of a combination of references"). Read together, the Khan '786 patent and the Motoyama reference suggest using the monoterpenes in lemon oil,

peppermint oil, and spearmint oil in conjunction with CoQ10.

3. Soft Gel further contends that a person of ordinary skill in the art would not have had a reasonable expectation of success in combining the references to use d-limonene in Motoyama's invention. Soft Gel points out that Motoyama, Nazzal, and the Khan '786 patent do not expressly mention d-limonene. Based on that omission, Soft Gel argues that a person of skill in the art would not have expected d-limonene to function like the carvone disclosed in Motoyama.

But Soft Gel ignores the finding that the main constituent of lemon oil, as used in Nazzal and the Khan '786 patent, is d-limonene, and the statement in Motoyama that the oil solvent that was the subject of Motoyama's invention includes "terpenes" such as d-limonene. Motoyama at 5. Soft Gel also fails to account for the recommendations in the Nazzal reference. After describing the same formulation that is disclosed in the Khan '786 patent, Nazzal recommends further study of the "nature of the interaction that exists between CoQ[10] and essential oils" and, more specifically, the "[c]hemical components of essential oils, such as limonene, menthone, and carvone." Nazzal at 246. As the Board noted, those recommendations for future research show that a person of skill in the art would have recognized—and at least one (Nazzal) did recognize—that the monoterpenes limonene and carvone are of interest in the essential oil-CoQ10 mixtures. Upon reading about carvone's role in dissolving CoQ10 in Motoyama, a skilled artisan would have been motivated to combine the two references. Because (1) Nazzal suggests testing the interaction of carvone and CoQ10 as well as the interaction of limonene and CoQ10, and (2) Motoyama teaches that carvone successfully dissolves CoQ10, a person of skill would reasonably expect that limonene, like carvone, would successfully dissolve CoQ10. A person of skill also would likely expect d-

limonene to work, consistent with Nazzal's recommendation to study limonene based on his testing of lemon oil, of which d-limonene is the main constituent.

Soft Gel highlights a 2004 article co-authored by Dr. Khan, which evaluates the use of l- and d-limonene in SNEDDS. Anitha Palamakula et al., *Preparation and* In Vitro *Characterization of Self-Nanoemulsified Drug Delivery Systems of Coenzyme Q10 Using Chiral Essential Oil Components*, Pharm. Tech. 74 (Oct. 2004) ("Palamakula"). According to Soft Gel, the reason that Dr. Khan conducted that "follow[] up" research was because it must not have been obvious that the lemon oil results in his earlier experiments were attributable to d-limonene. Appeal No. 17-1051, Appellant's Br. at 17-18.

In making that argument, Soft Gel applies an incorrect legal standard for obviousness, requiring "absolute predictability" rather than "a reasonable expectation of success." *Noelle v. Lederman*, 355 F.3d 1343, 1352 (Fed. Cir. 2004). It is true that the Khan '786 patent discloses lemon oil, not d-limonene. But that does not mean that a person of skill would not expect d-limonene, the main constituent of lemon oil, to work. Dr. Khan may have had just that expectation in conducting his subsequent research, in which he investigated whether d-limonene was responsible for the lemon oil-CoQ10 results. As the Board correctly noted, "[s]imply because [Dr.] Khan . . . [later] undertook a study to evaluate limonenes in SNEDDS[] does not mean that it would not have been obvious [that limonenes] would have worked to some extent." A supplemental study does not imply lack of awareness of the likely result; rather, studies are frequently conducted to confirm what is suspected to be true. An incentive to conduct a confirmatory study frequently exists even when one has every reason to expect success. As it happens, Dr. Khan was successful; his "[r]esults indicated that CoQ[10] is fairly soluble in [the] monoterpene[] [d]-limonene." Palamakula at 78.

* * *

Separately, Soft Gel complains that the Board's decision regarding the '072 patent must be reversed because in that opinion the Board ignored the fact that the claims were amended to recite "d-limonene" instead of "limonene." The Board's error in that regard, however, had no material effect on its obviousness decision and was therefore harmless. The IARC and Fenaroli references make clear that the main constituent in the lemon oil that was the subject of the Khan '786 patent is d-limonene; therefore, combining the Khan '786 patent with Motoyama suggests dissolving CoQ10 in d-limonene.

AFFIRMED