Checking the Oil for Snacks

http://www.foodproductdesign.com/
By: R.J. Foster, Contributing Editor
Posted on: 10/23/2009

PRINT

Historians believe that ancient Egyptian teenagers worked their way through college frying dough in hot oil for hungry pyramid construction crews. Unaware of their chemistry or effects on stability or human health, oils were chosen for cooking because they made foods very hot and very tasty in a very short time.

Snack-science has evolved, though. Today we know that frying is a complex process that impacts the oil, the snacks and the health of the snackers. Modern consumers demand more than great taste. Growing awareness of the impact that fried foods have on health has given rise to a new request on the part of fried-food consumers: healthy.

Hot stuff

Theoretically, any oil can be used for frying, but all oils are not the same. Typical frying temperatures range from 350 to 375°F, but can easily rise even higher. Oils for frying must be selected with several characteristics in mind if they are to withstand these rigorous conditions without adverse effects.

In general, oils with low-molecular-weight fatty acids will exhibit lower smoke-point temperatures than oils with similar levels of higher-molecular-weight fatty acids. Oils with greater amounts of free fatty acids will have lower smoke points. And, as frying progresses, free-fatty-acid levels increase and smoke point decreases. Developers working with frying systems should not consider oils with a smoke point lower than 392°F.

Saturation science

Another factor that affects fry stability is saturation. Fatty acids are arranged in carbon chains ranging in length from 4 to 26 carbon atoms. When a chain contains no double bonds, it has the maximum possible number of hydrogen atoms and is referred to as saturated. Double bonds between the carbons have less hydrogen atoms, or unsaturation of the bond.

Gerald McNeill, director of R&D, Loders Croklaan, Channahon, IL, notes that, as saturation decreases, so does stability. “Going from one double bond to two causes a ten-fold increase in reactivity to air,” he says. “Adding another double bond increases reactivity to air another ten-fold.” Years ago, processors were eager to use the more-stable saturated fats. Research by health experts, however, indicated that saturated fats were linked to increased risk of coronary heart disease, so the industry looked at unsaturated fats. Mono- and polyunsaturated fats were hailed for their ability to lower the levels of bad cholesterol in the blood, and reduce the risks for heart disease and stroke.

Unsaturated oils are, however, more susceptible to degradation under frying conditions. “High levels of unsaturated fatty acids in oils, such soybean oil and canola oil, can reduce the shelf life of the oil, reduce fry life, and give rise to undesirable flavors in fried products, including a ‘fishy’ flavor,” says John Radcliffe, Ph.D., R.D., professor of nutrition and food sciences, Texas Woman’s University, Denton. “The real problem with canola and soy oils is the high levels of linolenic acid, an unsaturated fatty acid.”

Additionally, the healthiness of unsaturated fats may diminish under frying conditions. McNeill points out that breakdown products from polyunsaturates may be more harmful than those obtained from monounsaturates or saturates. Heating oil can produce thermal degradation products such as *trans* bonds, peroxides, free radicals and hydroxy alkenals.

What’s more, unstable oils can affect the life of the snack product. Compounds in oxidized oil, especially if the frying oil is abused, can act as strong catalysts and cause further degradation of the oil that has been taken up by the fried snack product during its subsequent storage. Free fatty acids and other degradation products can increase the fat pickup in the finished product.

McNeill says perceived health benefits and dangers of saturated fats may not be valid after all. "Stearic acid was once believed to convert to the healthier monounsaturate oleic acid. Research has shown that this conversion does not occur. And, while it does not increase low-density-lipoprotein (LDL, “bad” cholesterol), it does not increase high-density lipoprotein (HDL, “good” cholesterol) either. Conversely, other fatty acids, like palmitic, increase LDL as well as HDL. In fact, because all saturated fats do both good and bad things, they are not as ‘harmful’ to humans as was once believed.”

Still, consumers maintained a generally negative perception of saturated fats, and the demand to reduce or eliminate saturated fats grew. The industry responded by adapting a technology initially used for hardening soaps: hydrogenation. While there are small amounts of *trans* fats found in animal products and milkfat, most dietary *trans* fats are created by the hydrogenation process.

Although increased degree of hydrogenation yields improved stability and resistance to deterioration, clinical studies indicate that *trans* fatty acids elevate cholesterol levels even more than saturated fats, and elevate LDL and decrease HDL compared to *cis* fats. In 2004, 45% of Americans surveyed said they were seeking products without *trans* fats. In Jan. 2006, FDA began requiring manufacturers to include *trans* fats on their nutrition labels.

Frying *trans*-itions

While debate ensues over whether saturated fats are as bad for us as was once thought, reducing or eliminating *trans* fats has moved to the top of the nutritional to-do list.

"Oils that have higher levels of saturated fatty acids, such as cottonseed oil (26% saturated fatty acids), do not need to be hydrogenated and can replace hydrogenated oils in the production of fried foods such as french fries," notes Radcliffe. No hydrogenation means no *trans* fats, while natural stability and high smoke point—about 450°F—provide cost savings in reduced turnover.

McNeill points to palm oil as another potential substitute for hydrogenated oils. Palm oil contains no linolenic acid and only 10% other polyunsaturated fats. The remaining fatty acid content is a balance of monounsaturates and saturates, giving sufficient stability for heavy-duty frying without hydrogenation. A semisolid at room temperature, palm oil can be customized through fractionation. Oil is heated and allowed to cool slowly. Large fat crystals form and are removed, leaving liquid oil behind.

Palm oil fractions can be blended back together to bring out specific functionality, or with other oils to combine the advantages of both. "Blending fractionated palm with soybean oil offers high stability for frying with low saturated fat and no *trans* fats," McNeill says, adding that blending with commodity oils, like soybean, ensures ample availability without the costs often associated with so-called designer oils.

Trait-enhancement is providing traditional oil sources with new nutritional benefits, according to Linsen Liu, oils and shortenings applications manager, Cargill, Minneapolis. Trait-enhanced soybeans have been developed to have a genetic makeup that results in lower levels of linolenic acid in the oil they produce. Linolenic acid (C18:3) is most prone to oxidation; linoleic acid (C18:2) is less reactive than linolenic acid; and oleic acid (C18:1) is the most stable to oxidation of the three. Therefore, low-linolenic soy oil provides good stability and functionality for frying applications, with zero *trans* fats.

High-oleic canola oil has been developed from canola seeds that are higher in monounsaturates and lower in linolenic fatty acids. This oil maintains the same low saturated-fat content (7%) of conventional canola oil and has zero grams *trans* fat per serving without hydrogenation. Liu notes that, because of the high oleic-acid content, this oil lasts longer, so it's good for frying. A new high-oleic canola oil with 4.0% to 4.5% saturated fat is under development and will be available for customer testing in early 2010.

Similar in the health benefits they deliver, high-oleic canola oil is slightly more stable, while low-linolenic soybean oil is typically slightly less expensive. Additionally, there is a flavor difference that should be considered when selecting an oil for a snack-food application. "Low-linolenic soybean oil has similar flavor to generic soybean oil, which may or may be not preferred by certain demographic users," Liu says. "High-oleic canola oils have cleaner flavors than generic canola and soybean oils."

One other consideration for choosing a frying fat for a snack food is its effect on the mouthfeel and appearance. If the finished product requires a drier, less greasy-tasting product, it's best to look for oil that has a higher solid fat index at room temperature than one used for a snack that requires a shinier, oilier surface.

Less is more?

In the midst of growing technologies, there is also growing interest in a less-complicated method of oil extraction. Expeller-pressing is a process of crushing seeds until the oil is released. It uses no chemicals, and applies no external heat. While yields are low compared to chemical processes—roughly 66%—expeller-pressed oils contain natural antioxidants that persist longer than those added to traditionally processed oils, providing fry life similar to that of a partially hydrogenated oil without hydrogenation, and without the *trans* fats.

The USDA-ARS's Food and Industrial Oil Research group, Peoria, IL, has looked at expeller pressing oils with modified fatty-acid composition, such as low linolenic acid, to see if these unhydrogenated oils compared favorably with commercially available frying oils in terms of quality and stability. Researchers conducted continuous pilot-plant frying studies with expeller-pressed soybean oil; low-linolenic-acid expeller-pressed soybean oil; high-oleic sunflower oil; corn oil; and hydrogenated soybean oil. The flavor quality of chips fried in expeller-pressed low-linolenic-acid soybean oil was significantly better than chips fried in hydrogenated soybean oil or high-oleic sunflower oil, and there was less fishy flavor and lower levels of hexanal after four months of storage than chips fried in expeller-pressed soybean oil. Both expeller-pressed soybean oils had longer fry lives than conventional corn oil.

One of the most-common natural antioxidants found in vegetable oils for frying are tocopherols, which are present in four different forms in varying amounts, as well as their corresponding tocotrienols. Gamma- and delta-tocopherols and tocotrienols help prevent autoxidation, while alpha-tocopherol protects against oxidation reactions induced by light. While adding tocopherols or tocotrienols can increase frying-oil stability, the antioxidant effect depends on the oil's fatty acid composition and the type and level of naturally occuring tocopherols. Excessive tocopherols in the oil can actually decrease its oxidative stability.

R. J. Foster is a wordsmith with a B.S. in food science from the University of Wisconsin-Madison and over 15 years of experience in the food industry. He can be reached through his website, wordsmithingbyfoster.com.