Healthier replacers for margarine in dough products

Team 4

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Abstract: In this report, we tried to give a summary of our research on the challenge topic "Healthier replacers for margarine in dough products". Through our investigation of various alternatives, in the report we recommend light margarine as a viable option due to its reduced saturated fat content and avoidance of trans fats during production.

What is margarine and why we need to replace Margarine?

Margarine is a blend of oils that are mostly unsaturated fat. It is made from oil (such as soybean, sunflower, palm, palm kernel, or canola oil), water, salt, and a few additional ingredients such as emulsifiers.

If we look at the history margarine was first invented (from beef tallow churned with milk) as a cheaper alternative of butter to feed French army and its poorer nation. Initially, margarine may have been meant for the military, but margarine soon crossed over to the mainstream, becoming a popular grocery item all over the world. It was considerably cheaper than butter, making it a good value for many working families. Over the time, there have been changes in the production of margarine. In 1902, because of the problem of beef tallow shortage for margarine production, Wilhelm Norman in Germany patented a process to harden oils by **hydrogenation.** Margarine no longer made of beef tallow, it came to be made with vegetable oils like canola and soybean [1,2].

The **process of combining unsaturated fat with hydrogen** to convert it partially or completely into saturated fat (solid) is called **hydrogenation**. And hydrogenation is one of the main ways to make margarine as we know today.

Depending on the brands and types of margarine, its ingredients may differ. Here are the ingredients that we can meet in the production of margarine:

- Vegetable oils, such as soybean, sunflower, palm, palm kernel, or canola oil, providing the primary fat content.
- Water - to create the emulsion and adjust the consistency of the margarine.
- To help stabilize the oil in water emulsion and prevent separation, emulsifiers, such as soy lecithin and mono and diglycerides, are added.
- For flavour enhancement and preservation salt is usually added.
- In some formulations, milk solids for flavour and texture might be added.
- Vitamins, such as vitamin A and D, often added to fortify the product.
- To enhance the appearance and taste, especially in products designed to resemble butter, colorants (beta-Carotene) and flavourings might be added [3].

The nutrition facts of margarine can also vary depending on the brand and type. However, here are some general nutrition facts[1] for a typical serving size of margarine (1 tablespoon):

Calories: Approximately 100-120 calories

Total Fat: Around 11-14 grams

Saturated Fat: Varies, but can range from 2-4 grams

Trans Fat: Some margarines may contain small amounts of trans fats, while others may be trans fat-free

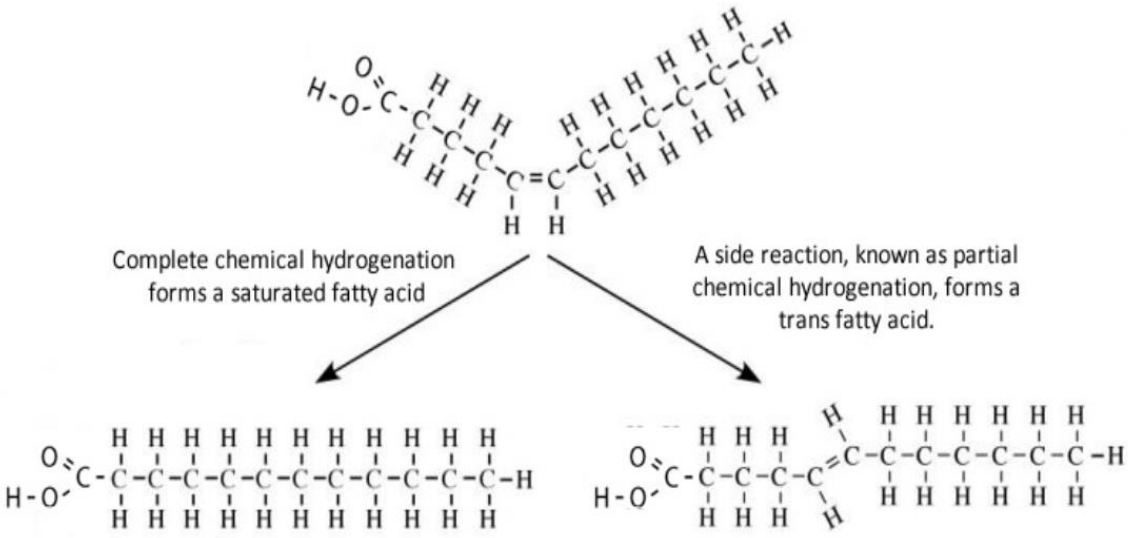
Cholesterol: Usually 0 milligrams

Sodium: Typically, around 90-120 milligrams

Carbohydrates: Negligible amounts, usually less than 1 gram

Protein: Negligible amounts, usually less than 1 gram

Now we know that the margarine making process is known as hydrogenation. This process transforms liquid vegetable oils, which contain beneficial unsaturated fatty acids, into a solid form at room temperature. However, in this process, we can also see the formation of **trans fats**, which are considered harmful to the body.



http://www.dynamicscience.com.au/tester/solutions1/chemistry/foodchemistry/fats1.html

[1] It's important to note that these values can differ among different brands and types of margarine.

Researchers eventually found that trans fats — which margarine contains — reduce the levels of high-density lipoprotein (HDL), or “good,” cholesterol and raise low-density lipoprotein (LDL), or “bad,” cholesterol levels, increasing the risks of various diseases such as cardiovascular diseases, hypertension, Alzheimer's disease, heart disease and stroke, diabetes, and certain cancers [4,5]. The World Health Organization (WHO) has an announcement in May 2018 to completely remove *trans*-fat from processed foods by 2023 that could help millions of people who die from the aforementioned diseases every year [5]. Therefore, it's important to check the product label and ingredient list to determine the trans-fat content of a specific margarine, Fig 1.

Along with trans fats, saturated fats that make up the main composition of butter, are considered harmful to the body. Generally, consuming excess fat can increase body weight and raise the risk of obesity. Obesity is a risk factor for heart disease. Heart disease is the most common cause of death worldwide.

Fig 1. The ingredients of margarine product. https://healthylivingpc.com/butter-vs-margarine/

While margarine was initially marketed as a healthier alternative to butter due to its lower saturated fat content, the health effects of margarine have been a topic of debate not only becouse of its bad trans fat content but also other reasons like:

Omega-6 fatty acids: Margarine is typically high in omega-6 fatty acids, which are essential fats but need to be balanced with omega-3 fatty acids. An excessive intake

of omega-6 fatty acids without enough omega-3s can promote inflammation in the body and contribute to chronic diseases [6].

Nutrient deficiencies: Margarine often lacks essential nutrients found in butter, such as fat-soluble vitamins (A, D, E, K), iodine, and other beneficial compounds naturally present in dairy products.

Artificial additives: Margarine may contain artificial additives like emulsifiers (such as lecithin), preservatives, colorings , and flavorings. Some people may be sensitive or allergic to these additives, leading to adverse reactions [7].

Therefore, lately it is becoming curtail to reform the margarine products to be trans fat-free and contain healthier ingredients or replace them with other available healthier alternatives.

People demend for margarine in Uzbekistan.

Before we launch to the healthier replacers of margarine, we determined the people demand for margarine in Uzbekistan. To find out how many individuals use margarine in baking and cooking, we conducted a small-scale online survey among 96 people. It is reasonable to mention that most of the people who filled out this questionnaire were women. When we asked them what type of oil they use for baking, we knew that almost half of the people (n=43, 44.8%) who completed the questionnaire use sunflower oil, while 28.1% of people use margarine as the second most common product, **Fig 2**.

Fig 2. Demand of margarine in baking bread.

On the contrary, the questionnaire shows that the majority of the respondents (63.5%) use margarine for baking cakes and cockiest, **Fig 3**.

Fig 3. The percentage of people use of margarine in baking pastries.

Furthermore, while assessing their level of awareness of the detrimental effects of margarine on human health, we discovered that 25% (n=24) of the respondents were unaware of these effects, **Fig 4**.

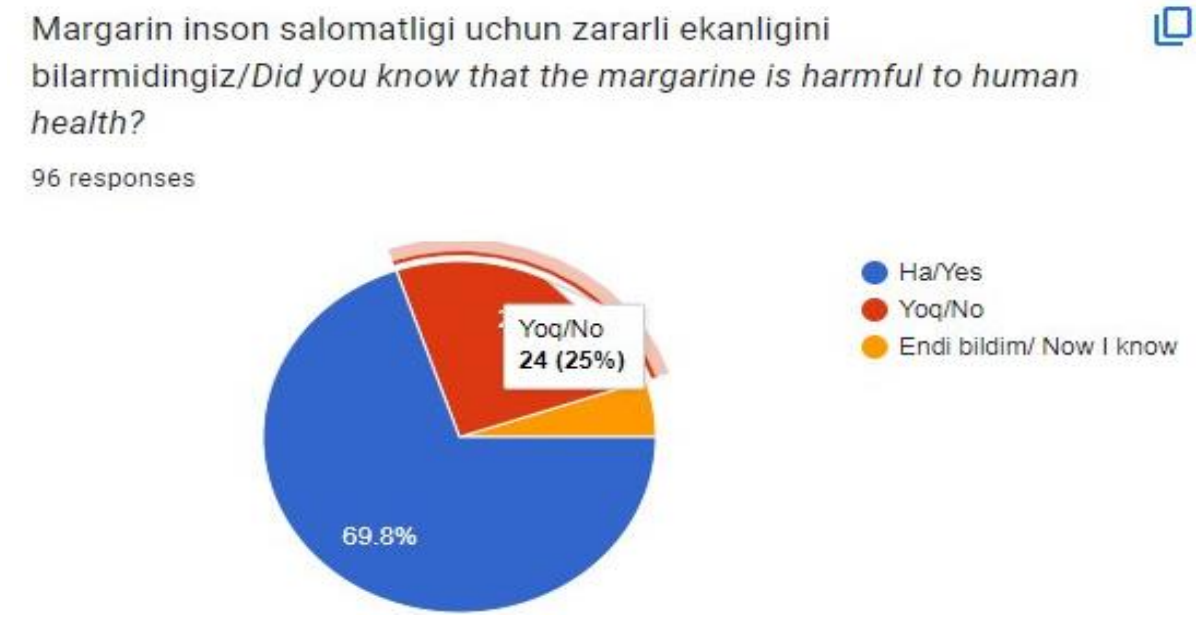


Fig 4.The percentage of people awareness about the bad effects of margarine.

In addition to our online survey, when we interviewed some local bakers, we found out that the most common margarine brands used by local bakeries in Tashkent are Ravon, Olmos, and "Моя мечта" and they contain high levels of trans fats. The

most unfortunate part is that most of the bakers either don't care about it or are unaware of the harm that margarine trans fats inflict to the body.

Healthier replacers for margarine!

The content of margarine and the detrimental impact of trans fats on human health were previously discussed. And yet, when researching marketing, we saw that trans-fat-containing margarine is widely available in our marketplaces and local bakeries utilize inferior types of margarine that contain a lot of trans fat. Considering this, what can we suggest?

We can replace margarine with other alternatives that are available in Uzbekistan. Here we listed some alternatives:

Butter. Butter cannot be a healthy replacer for margarine due to its saturated fat content. But in many cases, local people use butter directly instead of margarine.

Cream. Cream contains essential nutrients such as calcium and vitamins and offers a rich, natural dairy flavor that can enhance the taste and creamy texture of dough goods. But like butter, cream also contains a lot of saturated fat, so anyone on a low-fat diet could find it unsuitable. Furthermore, it might not have the same emulsifying qualities as margarine, which would change the consistency and texture of pastries. In addition, for individuals with dairy allergies or lactose intolerance, cream may not be a suitable alternative to margarine.

Yogurt. Yogurt contains healthy fats, such as unsaturated fats, which can be beneficial for heart health, and it is a natural source of probiotics. Yogurt can be used in various recipes and dishes as a substitute for margarine, adding a unique flavor and texture, but it may not provide the same texture and consistency as margarine in certain applications, such as baking or spreading. Yogurt generally has a lower fat content compared to margarine, which may affect the desired outcome in some recipes. Furthermore, the flavor of yogurt may not always complement certain dishes or baked goods as effectively as margarine.

Coconut oil, Canola oil, Palma oil, Avocado oil, Olive oil - they have several advantages as margarine alternatives, however they are liquid at room temperature (except for Coconut oil and Palma oil), so they may not replicate the texture and consistency of solid margarine in all recipes. And most importantly they are not originally grown in Uzbekistan (we were given advice to use the available source in Uzbekistan as much as possible).

Sunflower oil. Unlike other vegetable oils, sunflower oil's source (sunflower) is widely grown in Uzbekistan. Unsaturated fats, especially monounsaturated and polyunsaturated fats, are abundant in sunflower oil and may be good for heart health. Because of its subtle, neutral flavor, sunflower oil may be used in a variety of recipes without detracting from the flavor. Moreover, because of its high smoke point, it may be cooked at greater temperatures without degrading and releasing toxic chemicals. However, in other uses, such pastry making or baking, it might not have the same mouthfeel and texture as margarine. Furthermore, sunflower oil is liquid at room temperature, so in some recipes it might not be a perfect replacement for margarine's firm consistency. Trans fats, which have the potential to be harmful to health, may be present in certain sunflower oils [8].

We have seen that each of the alternatives discussed above has its pros and cons. While working on our challenge topic, we came across one very valid fact that there is no 100% healthful option when it comes to margarine (and butter also)!!!

Therefore, as good option, we stopped at **light margarine**, which is lower in calories and fat due to higher water content. Generally, there are various types of margarine available, among them the light margarine is lately getting more popular as a healthier option in many countries.

Here in this table, we have compared some light margarine parameters with those of other margarine alternatives.

Product	Price in the market(sum)	Saturated fat (100g)	Unsaturated fat (100g)	Trans fat (100g)	Calories (100g)	Cholesterol (100g)
Butter (from animal)	30 000	51.36	23	3.27	717	0.3
Cream	18 000	12	3	0.7	196	0.066
Margarine hard (sticky)	16000	3	10	3	526	0.03
Margarine light	25000	0.3-2	30	0 *	444	0
Olive oil	48000	14	83.5	0	884	0

***** *Light margarine may contain some amount of trans fat also*

From the table, we can see that compare to others, the light margarine has the lowest saturated fat content, modirate in unsaturated fat content and calories. It has to be consider that even though the light margarine contains less saturated fats than regular margarine, it may still contain some partially hydrogenated oils which can contribute to trans fats [4].

The traditional production of margarines consists of five main stages: preparation of the aqueous phase, preparation of the oil phase, emulsification, crystallization, and packaging [9], **Fig 5**.

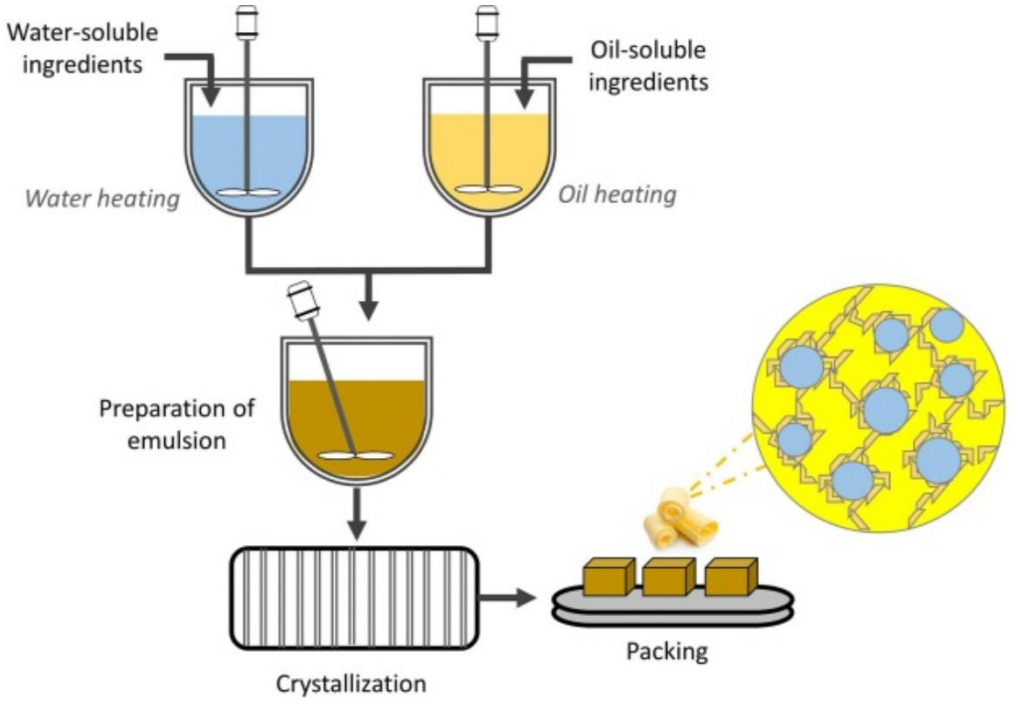


Fig 5. Margarine production process.

And based on this traditional technique, the production of trans fat-free margarine typically begins with the selection of oils that are naturally low in trans fats, such as liquid vegetable oils like soybean oil, (canola oil) and sunflower. In a separate tank (oil phase) under agitation and heat above the melting point of the oil, these selected oils (partially hydrogenated, interesterified),are melted with other lipophilic ingredients such as emulsifiers (lecithin, monoacylglycerols, fatty acid polyglycerol esters, sorbitan monostearate, sorbitan tristearate, etc.), colorings (β-carotene, urucum, curcumin, or turmeric extracts), antioxidants, and vitamins (A, D, and E) [3,10]. The aqueous phase is represented in another tank by water and water-soluble ingredients such as sodium chloride, antioxidants, acidity regulators, powder milk, and preservatives. After heating and solubilization of the ingredients in the aqueous and

oil phases, these systems are directed to a single mixing tank for emulsion formation. The next step chilling the emulsified mixture to solidify it into a spreadable consistency. The last step packaging the trans fat-free margarine for distribution and consumption.

In light margarine production, there might be seen partially hydrogenation. And during hydrogenation, since a cis unsaturated fat is heated at high pressure, in the presence of hydrogen gas and a nickel catalyst, might yield a trans double bond. So, it should be considered that some partially hydrogenated oils can contribute to trans fats formation.

In light margarine production to supply zero trans-fatty acids formation, the non-thermal plasma with needle-in-tube configuration might be used as Kunlanan Puprasit et all. effectively demonstrated in their research [5]. The advantages of this configuration were the low-temperature reaction facilitating zero *trans*-fatty acids formation and tube configuration confining generated hydrogen free radicals within the tube and forcing them to bubble through the oil layer, significantly enhancing the probability of contact with.

After the production of the margarine, we can determine the existence of trans fat in the product using IR Spectrophotometer, **Fig 6**.

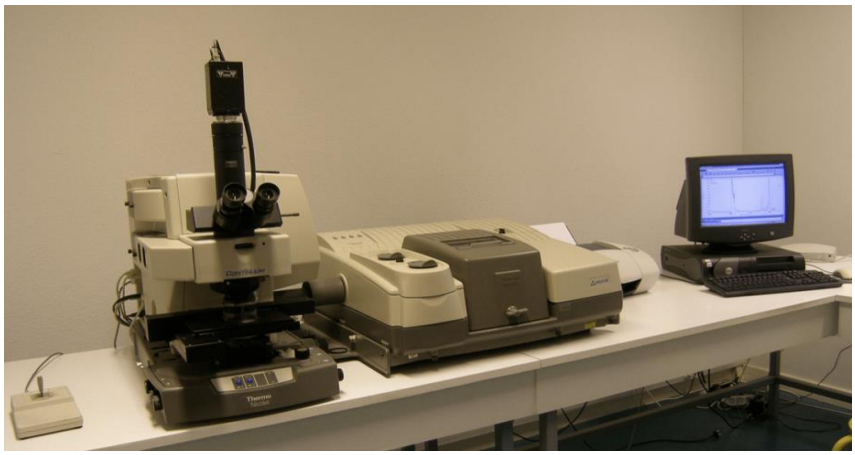


Fig 6. IR Spectrophotometry

Texture and sensory attributes. When compared to typical margarine or butter, light margarine can help dough products have a softer and more delicate feel. In baked products, it may contribute to a finer crumb structure. Dough goods may taste lighter and less oily when made using light margarine.

Conclusion.

In conclusion, we would like to recommend that people in Uzbekistan be made aware of the negative health consequences of margarine before implementing any

healthier substitute for margarine in dough goods. This is because, according to our online survey, 25% of respondents were unaware of these impacts. During our invastigataion on our challege, we realized that each sourcehas advantages and disadvantages of its own when looking for healthier substitutes for margarine. And we stopped at light margarine, which is made by lowering the saturated fat content and avoiding the creation of trans fats during the manufacturing process. Moreover, the use of light margarine offers the potential to improve the nutritional profile of dough products by reducing saturated fat content while maintaining desirable texture and sensory attributes. This alternative aligns with the growing consumer demand for healthier food options without compromising on taste and quality, making light margarine a viable choice for enhancing the healthfulness of baked goods.

Oleogels. Oleo gels are products of solidifying vegetable oils using natural wax esters. The oleo gelation process forms waxy crystal structure which hold liquid oil within a solid matrix, which allows the use of liquid vegetable oils in place of margarine. In one study by Santiago Bascuas et al. [11] when hydroxypropyl methylcellulose (HPMC) and xanthan gum (XG) were used as oleogelators to prepare oleogels, using sunflower and olive oil, as substitutes for margarine in baked or steamed buns, they did not meet any difference in meet the crumb structure, volume, height, and texture,

Fig 7.

Fig 7. Cross section of breads that are made using oleo gels. Baked control bun made with margarine (BC); baked bun made with olive oleogel (BO); baked bun made with sunflower oleogel (BS); steamed control bun made with margarine (SC); steamed bun made with olive oleogel (SO); steamed bun made with sunflower oleogel (SS).https://www.mdpi.com/2304-8158/10/8/1781

When the triangle test was performed by them, no textural variations were found between the margarine buns and the buns produced with oleogels. When oleogels were used in place of margarine in the baked and steamed buns, the degree of lipolysis remained same. Their results suggest that using oleogels instead of margarine in buns could represent an interesting strategy to prepare healthier bakery products.

Moreover, in another study [12] the oleogels was found that the ideal fat replacers for different types of low-fat baked products (in cake at 100% fat replacer).

Since formulating oliogels with desired properties for specific applications may require expertise and optimization and depending on the production process and raw materials, oliogels may have a higher cost compared to traditional margarine, we did not concider the oliogels as a good substitute for margarine in Uzbekistan conditions.

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