

STUDY OF THE EFFECT OF DRIED GINGER EXTRACT ON THE QUALITY OF MARGARINE

K. Rubanka, T. Levkivska, O. Dushchak

National University of Food Technologies

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Corresponding author:

K. Rubanka

E-mail:

rubanka_ekaterina@ukr.net

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ABSTRACT

The market of margarine is expanding worldwide due to large-scale trade, lower cost compared to butter, growth in the bakery and confectionery markets where margarine is used as a raw ingredient, and seasonal independence. The article reveals the expediency of adding dried ginger extract to the technology of margarine production, which allows to expand the range of the margarine production and extend its shelf life. Thus, the paper presents the results of research on the influence of different dosages of spicy raw materials from 0.5 to 4% on the acid and peroxide index of margarine during 90 days of storage in a refrigerator at a temperature of 4 °C without packaging. Research results confirm that plant extracts are natural inhibitors of oxidative processes, and therefore reduce both the peroxide and acid index of margarine during the recommended storage period of 60 days. Ginger, as a source of phenolic and polyphenolic compounds, which are represented by α - and β -zingiberene, sesquiterpene, camphene, cineole, etc., reduces the peroxide index of fat to 8.8%, and the acid index to 28%, in the case of adding 0.5% of extract. The investigated parameters naturally decreased when the dosage of the extract increased to 1, 2, and 4% compared to the control sample. For example, the peroxide index reduced to 28% and the acid index to 52% when 4% dried ginger extract was added compared to the sample without its addition. The addition of the studied raw material has a positive effect on the sensory parameters of margarine, giving it a spicy taste and aroma. The color of the fat also changes, becoming more yellow with an increase in the dosage of the extract. However, increasing the dosage to 4% leads to negative consequences, namely the appearance of a brown shade and margarine and the formation of a too burning taste, which was negatively perceived by the group of experts.

ДОСЛІДЖЕННЯ ВПЛИВУ ВИСУШЕНОГО ЕКСТРАКТУ ІМБИРУ НА ЯКІСТЬ МАРГАРИНУ

К. В. Рубанка, Т. М. Левківська, О. В. Душак

Національний університет харчових технологій

Ринок маргарину розширюється у всьому світі завдяки широкомасштабній торгівлі, нижчій вартості порівняно з вершковим маслом, зростанню ринків хлібобулочних і кондитерських виробів, де маргарин застосовується як сировинний інгредієнт і сезонній незалежності. В статті розкрито доцільність додавання екстракту імбиру в технології виробництва маргарину столового, що дає змогу розширити асортимент ринку маргарину та подовжити термін його зберігання. Наведено результати досліджень впливу різного дозування пряної сировини від 0,5 до 4% на кислотне та перекисне число маргарину впродовж 90 діб зберігання в холодильнику за температури 4 °C без упаковки. Результати досліджень підтверджують, що рослинні екстракти є природним інгібітором окисних процесів, а тому знижують як перекисне, так і кислотне число маргарину впродовж рекомендованого терміну зберігання 60 діб. Імбир як джерело фенольних і поліфенольних сполук, які представлені α - і β -цингібереном, сесквітерпеном, камфеном, цинеолом тощо, знижує перекисне число жиру до 8,8%, а кислотне — до 28%, у разі внесення 0,5% екстракту. Досліджувані показники закономірно знижувались у разі збільшення дозування екстракту до 1, 2 та 4% порівняно з контрольним зразком. Наприклад, перекисне число знижувалось до 28%, а кислотне число — до 52% у разі внесення 4% сухого екстракту імбиру порівняно зі зразком без внесення добавки. Додавання досліджуваної добавки позитивно впливає на органолептичні показники маргарину, надаючи йому пряного смаку й аромату. Також змінюється колір жиру, який стає жовтішим зі збільшенням дозування екстракту. Проте збільшення дозування добавки до 4% призводить до негативних наслідків, зокрема появи коричневого відтінку та утворення занадто пекучого смаку, що негативно сприймалось групою експертів.

Ключові слова: маргарин, екстракт імбиру, перекисне число, кислотне число.

Problem definition and its relationship with important practical tasks. Margarine is widely used as butter substitute in the food industry to impart a certain flavor and aroma to food products, which is produced in the process of heating margarine (Vidanagamage et al., 2016). For example, during the baking of flour confectionery and bakery products, during the production of second dishes in canning technology, as a component of the first and second lunch dishes of quick preparation, etc. In addition to vegetable fats, margarine contains a small percentage of proteins, carbohydrates and water, which makes it a suitable substrate for microorganisms (Vidanagamage et al., 2016). Although margarine spoilage most often occurs because of chemical rancidity due to fat hydrolysis, microbiological problems also occur, accompanied by the appearance of a cheesy, rotten or fruity aroma and a rancid aftertaste (Rady & Badr, 2003, Goryainova & Trykul, 2019). Preservatives prevent the biological deterioration of the product under the influence of microorganisms and bacteria, and antioxidants prevent their chemical oxidation.

The mechanism of action of antioxidants is also differs from the action of preservatives. They slow down the oxidation process by interacting with air oxygen, interrupting the oxidation reaction or destroying peroxides that have already formed. To reduce oxidative processes and microbiological spoilage of margarine, manufacturers often use synthetic antioxidants (phenol derivatives), for example, butylhydroxyanisole, butylhydroxytoluene, sodium isoscorbate and others. However, synthetic antioxidants can cause allergies. Therefore, scientists pay attention to the use of natural antioxidants, which, in addition to being safe substances, are also useful.

It is known that plants are natural components with a preservative effect due to the presence in their composition of phenolic, polyphenolic compounds, carotenoids, which are able to quickly react with peroxide radicals, destroy hydroperoxides without the formation of free radicals, which leads to chain breakage and slowing down the rate of oxidation. The introduction of antioxidants can also increase the nutritional and biological value of the product, which is confirmed by the studies of Palko (2009) and Horyainov (2019), who added walnut leaf powder and carrot powder, respectively, thereby increasing the nutritional value of margarine. Therefore, their use in the technology of fats of vegetable origin is relevant.

Analysis of recent studies and publications. It was proven that spices have a high potential as natural components with a preservative effect, which is one of the reasons for their wide use in the food industry, namely due to the presence of a wide range of antioxidants. Natural antioxidants are compounds that protect biological systems from the harmful effects of free radicals. Antioxidants can act as scavengers of free radicals and inhibitors of oxidative enzymes (Fanhani, & Ferreira, 2006). These properties are due to many substances, including some vitamins, flavonoids, terpenoids, carotenoids, phytoestrogens, minerals, etc. and render spices and some herbs or their antioxidant components as preservative agents in food (Calucci et al., 2003). Since the antioxidant compounds contained in spices (Рубанка, Терлецька, & Хвостик, 2020) effectively slow down the oxidative degradation of lipids and contribute to the preservation of the quality and nutritional value of the food products to which they are added, spices and their extracts are of increasing interest for food industry, including fat technology (Ozcan, Erel, & Herken, 2009).

Scientists from the Federal University of Lavras (Brazil) investigated the addition of a spice mixture containing green onions, garlic, marjoram, thyme, lemon, oregano and/or basil. According to their research, total phenolic content increased 5 times in chemical composition of margarine and there was significant increase ($p < 0.05$) in the antioxidant activity of the finished product (Oliveira Lopes, Piccolo Barcelos, Araujo Dias, Souza Carneiro, & Abreu, 2014). Adding rosemary extract to margarine increases its antioxidant activity by 200 ppm and, as a result, extends shelf life (Azizkhani, & Zandi, 2010). Panko (2009) proved that the use of walnut leaf powder in the amount of 0.5% with ascorbic acid in the amount of 0.2% allows to slow down the process of oxidative deterioration of margarine by 2.6 times. Ukrainian scientists (Лозова, & Давидович, 2008) claim that the substances of turmeric in combination with synergists have antioxidant properties and can be used to extend the shelf life of fats, since this technological method allowed to slow down the process of oxidative deterioration of fats almost 2 times. In addition, the introduction of natural antioxidants contained in spices makes it

possible to increase the biological value of products. Thus, scientists from different countries prove the expediency of using spices in margarine technology.

Ginger is not an exception. This spice is increasingly used in the confectionery industry, due to its spicy aroma, which is perfectly combined with flour confectionery products. The content of ascorbic acid in ginger is 48...66 mg %. Its content in the dry root of ginger exceeds the similar indicator in lemons, mountain ash, oranges, tangerines (Сімахіна, & Шевченко, 2014b). Sometimes there is used ginger extract. When using aqueous extracts, a significant part of bioflavonoids does not pass into the extractant. Therefore, in water-alcohol solutions of different concentrations, especially with a mass fraction of alcohol of 40%, the concentration of phenolic compounds extracted into the solution is quite significant — more than 3000 mg/dm³ (Сімахіна, & Шевченко, 2014a).

Adding ginger to margarine is one of the ways to increase the use of margarine and extend its shelf life due to the presence of essential compounds in it, such as α - and β -zingiberenes, sesquiterpenes, camphene, cineole, bisabolen, borneol, citral, linalool and at. Since it is known (Silva et al, 2021) that the listed compounds have antioxidant and inhibitory properties, and therefore should inhibit the rancidity of fats.

The purpose of this study was to improve the quality of table margarine by adding dried ginger extract, which is also a safe flavor additive.

Research methods. Table margarine with a fat content of 65% of TM "Schedro" produced by "Lviv Zhirkombinat" PrJSC was chosen as the object of research. Dried ginger extract with a mass fraction of moisture of 6.7% was added to the semi-finished margarine product (temperature 20—22 °C) in the amount of 0.5%, 1%, 1.5% and 2%.

Dry ginger extract was produced using double extraction with water with a ratio of raw material:water 1:15 at an elevated temperature of the extraction process of 90 °C for 3 hours. Subsequently, the condensed extract was dried to a dry matter content of 30% at a temperature of 60 °C then using a roller dryer to a moisture content of no more than 5%, followed by grinding to a particle size of 0.05...0.10 mm (Рубанка, Терлецька & Абрамова, 2017).

According to its structure and physical and chemical properties, ginger is a difficult-to-extract vegetable raw material, and therefore, during its extraction, conventional physical methods should be used to intensify internal mass transfer (Шевченко, Деканський, & Запорожець, 2014).

Mixing with simultaneous grinding was carried out in a laboratory disperser until a homogeneous suspension was obtained.

Margarine was stored in a refrigerator at a temperature of 4 °C for 90 days without packaging.

The peroxide index of fat is one of the main indicators of the quality of fat products, which characterizes the safety of the product, and therefore is regulated according to state standard of Ukraine (DSTU 4465:2005). Therefore, in the studied samples, the peroxide index of fat was determined after every 15 days of storage. This indicator was determined by the titrimetric method, which is based on the interaction of the oxidation products of vegetable oils and fats (peroxides and hydroperoxides) with potassium iodide in a solution of acetic acid and chloroform and in the subsequent quantitative determination of the released iodine with a solution of sodium thiosulfate by the titrimetric method (Fruehwirth et al, 2021).

The principle of the acid index determination method is based on the titration (neutralization) of free fatty acids with a solution of potassium or sodium hydroxide in the presence of the phenolphthalein indicator (Fruehwirth et al, 2021).

Statistical processing of experimental data was performed for three measurements of all studied properties, the discrepancy between studies did not exceed 5%.

The sensory assessment of fat quality was determined by a complex indicator (Шевченко, & Фурсік, 2023). 10 people of different age and social class were selected as experts. As a control sample, a sample of margarine was used, which met the norms of regulatory documentation for this type of product (DSTU 4465:2005 Margarine. General technical conditions).

Results and discussion. It is known (Silva at al., 2021) that in case of access of oxygen, light and increased relative humidity in the air to fats, their fatty acids are partially oxidized, which leads to the formation of peroxide, and the longer the oxidation process takes place, the higher the peroxide index of the fat increases. The change in the calorific value of margarine during its storage in the refrigerator with different contents of dried ginger extract was studied. The results of the research are shown in Fig. 1.

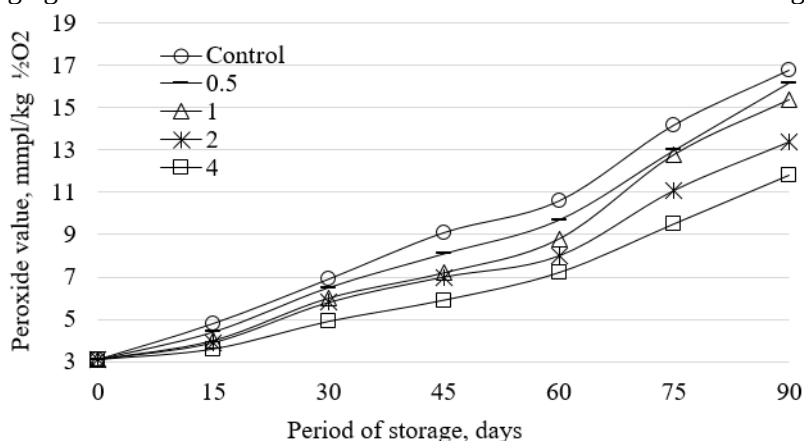


Fig. 1. Changes in the peroxide index of margarine during its storage

It was established that in all studied samples during 90 days of storage, a gradual increase in the peroxide index of fat is observed, but the oxidation process of margarine slows down with an increase in the dosage of dried ginger extract. Oxidation occurs due to free radical chain reactions, which are accompanied at the first stages by the formation of peroxides and hydroperoxides (Fanhani, & Ferreira, 2006). However, the presence of natural antioxidants, such as α - and β -zingiberenes, sesquiterpenes, camphene, cineole, bisabolene, borneol, citral, linalool, etc. (Spence, 2023), which are part of the dried ginger extract, reduce the oxidative transformation of fats, which suppress the activation of free radical reactions lipid peroxidation (Fanhani, & Ferreira, 2006) that is confirmed by our research results. Thus, at the first stages of margarine storage, the peroxide index in all samples is almost the same and is within 3.6...4.5 mmol/kg $\frac{1}{2} O_2$.

At the end of the recommended storage period 60 days according to DSTU 4465:2005 Margarine. General technical conditions, the peroxide index for the control sample was 10.2 mmol/kg $\frac{1}{2} O_2$, while with the addition of 4% dried ginger extract, this

indicator decreased by 28%, even in the case of adding a small amount of extract (0.5%), the peroxide index decreased by 8.8% compared to the control sample. A further increase in the storage period led to a sharp rise in the peroxide index of margarine, but even during storage for 90 days, this indicator was lower than the control sample: in the case of adding 0.5% dried ginger extract, the peroxide index of margarine was lower by 4.1%, in the sample with 1% dried ginger extract — by 7.1%, in case of 2% dried ginger extract — by 21.4% and in the sample with 4% dried ginger extract — by 30.3%.

It is known (Silva et al., 2021) that the acid index characterizes the process of enzymatic or non-enzymatic hydrolysis of fat, namely the breakdown of fat with the formation of fatty acids, which can contribute to the acceleration of the oxidation process because of free, unbound in triglycerides acids. Thus, the acid index characterizes the quality of fats, which indicates the total content of free fatty acids.

In order to confirm the obtained results, the patterns of oxidation of margarine samples were determined in the case of adding different amount of dried ginger extract. The results of studying the acid index of margarine during its storage are presented in Fig. 2.

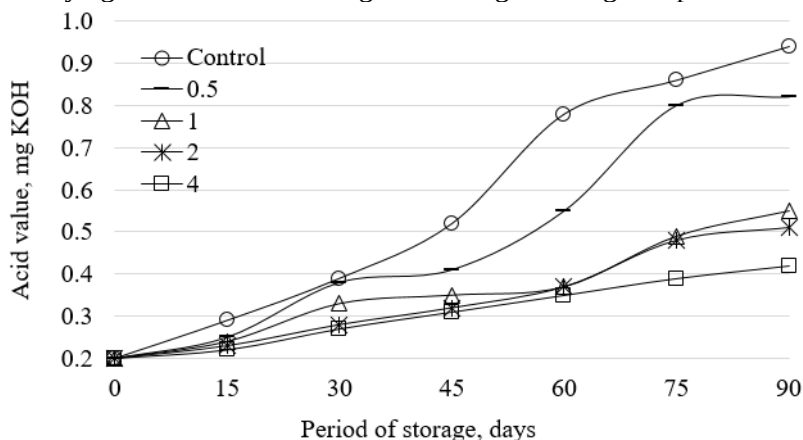


Fig. 2. Changes in the acid index of table margarine during its storage

It was confirmed that in the process of margarine storage, its acid index increased gradually, and with increased dosage of dried ginger extract, this indicator naturally decreased, which indicates the accumulation of free acids, however, dried ginger extract inhibits oxidation processes, selecting free radical chain reactions and at the same time, it reduces the hydrolysis of acylglycerides (Spence, 2023).

The acid index in the control sample increased and reached 0.76 mg of KOH after 60 days of storage. In samples of margarine with the addition of dried ginger extract, the acid index, for the same storage period, was lower than in the control sample by 28%, 51%, 52% and 52% for samples with the addition of 0.5, 1, 2 and 4% of dried ginger extract, in accordance.

An increase of this indicator was observed on the 90th day of storage in all samples. But even 0.5% of dried ginger extract reduced the acid index by 12% compared to the control, while 2% — by 46% and 4% — by 53%. The obtained research results confirm the statement that phenolic compounds of plant raw materials are natural preservatives,

including ginger, the extract of which is a concentrate of water-soluble compounds, not excluding phenolic substances.

Dry ginger extract affects not only the oxidation processes in margarine during storage, but also the sensory indicators, which in turn will also affect the finished product in which margarine is used as a recipe ingredient. Therefore, the taste, smell, consistency and color of margarine were determined. The results of sensory indicators of margarines and their comprehensive quality index (K) are presented in fig. 3.

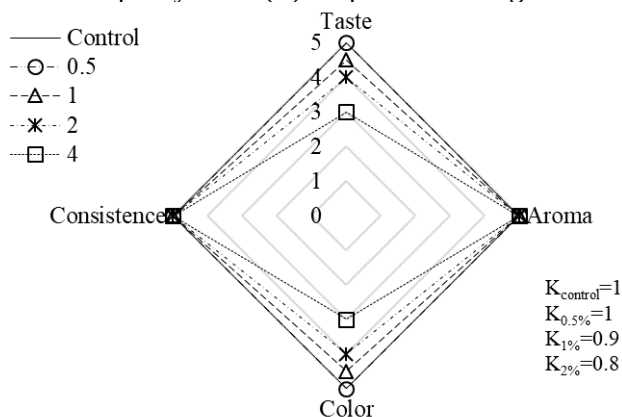


Fig. 3. Effect of dried ginger extract on the sensory parameters of margarine

It was determined that even with a small addition of dried ginger extract (the amount of 0.5%), margarine acquired a spicy taste and aroma. With an increase in the dosage of the extract, the spicy taste and aroma became more saturated, and with the amount of 2% and 4%, this indicator acquired a strong spicy taste, which was accompanied by the appearance of a burning taste. A similar pattern was observed in case of color analysis, which did not change when 0.5% and 1% were added and became one tone yellower when 2% dried ginger extract was added. When adding 4%, the margarine had a brown tint, which was negatively perceived by experts. At the same time, the dried ginger extract did not affect the consistency of margarine, which did not change when the dosage of the extract was increased.

Conclusions

Thus, the presence of phenolic compounds in the composition of dried ginger extract allows to reduce the oxidative reactions that occur with fat during its storage and to partially extend its shelf life, which is confirmed by studies of the chemical transformation of fat during margarine storage. Even a small addition of dried ginger extract reduces the peroxide value of fat to 8.8%, and the acid value to 28%. The addition of dried ginger extract to table margarine has a positive effect on its sensory indicators. Therefore, in order to establish the optimal dosage of dried ginger extract, it is necessary to take into account the influence of dried ginger extract on the physico-chemical and microbiological indicators of the quality of table margarine during its storage, which will allow taking into account the influence of ginger not only on the quality, but also on the safety of the product. These researches are planned to do.

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