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Investigation of physicochemical, microbial and fatty acids profile of table margarine made with palm and soybean oils

Mahboubeh Zaeroomali[1*], Yahya Maghsoudlou[1], Peyman Aryaey[1] and Leila Nateghi[2]

[1]Department of Food Science and Technology, Science and Research Ayatollah Amoli Branch, Islamic Azad University, Amol, Iran
[2]Department of Food Science and Technology, Varamin-Pishva Branch, Islamic Azad University, Varamin, Iran

ABSTRACT

In this study table margarine was made based on palm and soybean oil oils and then its physicochemical and microbial properties as well as fatty acids profile were investigated. Peroxide value, acid value iodine value and refraction index of this sample were 0.32 meq/kg, 0.13%, 65.74 and 1.4597, respectively. Microbiological examinations showed that the sample was microbiologically according to national standard. Its main fatty acid was oleic acid and its total trans fatty acids content was up to 3.66.

INTRODUCTION

Margarine was produced, for the first time, by a French chemist, named Hippolyte Mege Mouries in 1896. Margarines, originally, were made of animal reserved fats such as bovine fat. In the late 19 th, gradually a mixture of animal fats and vegetable oils were used and in the early of 20 th, margarine was produced using 100% vegetable oil (coconut and palm nut) (chrysan, 2005). According to codex international standard, margarine is a water–in–oil emulsion made basically of edible oils and fats. It should contain minimum 80% fat and maximum 16% water (codex, 2001). Oils and fats are the most important ingredients clearly attributed to the characteristics of final margarine. The type of used oils and fats has distinct effect on crystallization properties during margarine processing. Commonly a mixture of two or more different oils is used to make margarine. Palm olein is one of widely used oils usually applied along with other oils (chrysan, 2005).

Soybean oil has a favorable composition of fatty acids and it has beneficial effect on human health, therefore it is suitable oil for manufacturing margarine beside of palm oil.

Since a considerable part of margarine formulation consists of water, different additives including salt, emulsifier, etc, are added in order to maintain its quality. Emulsifiers have three functions in margarine: (1) helping in emulsion formation, (2) changing crystalline structure of vegetable oils and (3) preventing coalescence of water drops and their spattering during margarine heating (Hamilton, 1994). The best and most effective emulsifiers for preventing alteration of oil crystals are sorbitan mono- and di-stearat and citric acid esters mono glycerides (chrysan, 2005). Salt is added to provide desirable taste and preservative property. According to Iranian national Standard, the added salt must not exceed 2%. Salt, if in enough amount, prevents growth and activity of some microorganisms in margarine. This amount of salt is not commonly sufficient to prevent spoilage of margarine so, it is required to use other preservatives particularly anti-fungus and mold substances, such as sorbic and benzoic acids and their salts (Lin, 2002). Today, manufacture and consumption of margarine is growing worldwide, because it is less saturated than butter and has no cholesterol resulting in reduced incidence of cardiovascular diseases. The objective of this study was, made a kind of table margarine including plam and soybean oil and investigates its physicochemical, microbial and sensory properties of that.

MATERIALS AND METHODS

A kind of table margarine was produced using the formulation presented in Table 1. Potassium sorbat and citric acid were purchased from Aryan shimi Co. Butter essence, Firmenich brand, Swiss, ordered by Nasim–e–Sabah Co., glycerol mono-stearat, china, ordered by Pars Behbood Asia Co., iodine – less salt, Iranian salt purification food & industry co., and non-fat milk powder, Zarrin shad food industries co., were purchased.

Methods

Measurements of peroxide value, acid value salt content, melting point, refraction index, iodine value, and moisture content were performed according to national standard No. 4179, 4178, 87981, 4887, 5108, 4886, 7513, respectively. Heavy metals content measured according to national standard No. 4088 and 4089. These metals include iron, copper, lead, arsenic and nickel. The test was conducted using Atomic absorption spectrometer.

Fatty acids profile

The results were obtained by use of GC model Agilent 6890. Gas chromatography was applied to identify and determine the fatty acids composition. To do so, the sample was prepared as methyl ester derivative using 5% normal sodium monoxide. Then, to examine the fatty acids profile, GC model Acme 6000 equipped with flame detector and 60 m column was used according to AOCS standard No. 940.28.

Color was examined by use of laviband according to national standard No. 7513.

Oxidation stability of all treatments was determined by Rancimat according to national standard No. 7513.

Microbial tests including mold and yeast, E. coli, staphylococcus aureus, and total count was performed according to national standard No. 10899-2, 6806-2, and 5272-, respectively.

RESULTS AND DISCUSSION

The results of physicochemical tests of the produced table margarine are presented in Table 2. In all food stuff, water content is the most important factor of biological and chemical food spoilage, so water content of foods should be specified to determine the shelf-life in final product. Codex international standard approves maximum, water content of margarine as 16%. As shown in Table 2, the moisture content of this product is 19.9 exceeding the codex acceptable amount.

Peroxide is the primary product of fat oxidation and generally, the higher degree of unsaturation of fats and oil, the more prone to oxidation. When peroxide amount is in certain – level different reaction occur in fats and oils resulting in produced keton and aldehyde volatile substances as well as short chain fatty acids contributed to undesirable aroma and flavor. Thus, although the produced peroxide is not direct cause of these undesirable qualities, it indicates the oxidation progress degree. In the early stages, peroxide is produced slowly ranging from a few weeks to a few months depending on type of oil, storage circumstances, temperature, etc., then its production accelerates and peroxide, itself, participates in oil oxidation as an catalyst. Therefore, measuring peroxide, as an index of oxidation progress, quality and shelf – life of oils is important. Peroxide content of the produced sample is 0.35 mEq/kg which is below the acceptable amount stated by Iranian national standard (2 meq/kg), therefore experiment samples showing good quality and manufacturing conditions. The values of peroxide recorded in this study were similar with the results obtained by Aziz khani *et al*, 2006, that produced margarine with palm stearin and sunflower oil and reported that peroxide value was 0.4 meq/kg. All types of oil contain an insignificant certain amount of free fatty acid which may exceed the allowed level due to rancidity agents and hydrolysis reaction. Moisture present in the product accelerates hydrolysis reactions.

Acidity thus is an index which helps us to identify any rancidity in oils and fats. Acidity of oils and fats is mostly measured on the basis of olecic acid. Acidity value of the produced sample is 0.13% being in the range stated by national standard. This result was agreed with Azarifar *et al*, (2009), who investigated the properties of margarine with 16 % moisture that produced by palm olein and canola. The acidity of its samples was between 0.06% to 0.14%. Salt is added to margarine formulation in order to improve its flavor and shelf-life as, well as well prevents growth and activity of some microorganisms. Usually, this amount of salt is not sufficient to preserve quality of margarine, so it is required to use other preservatives such as sorbic acid and benzoic acids (Lin, 2002). The permitted level of these additives is 1000 ppm. The amount of these preservatives in the produced sample is 520.50 ppm, being in the permitted range.

Slip point of margarine is directly dependent fatty acids of formulation such that the more saturated fatty acids showed the higher slip point. The slip point of the table margarine in current study was 3.5.5°C. According to national standard the highest slip point of table margarine should be 37°C. Therefore the slip point of produced sample is acceptable. The result of current research were in agreement with those reported by Aziz khani *et al* ,2006 who reported that melting point of its samples was 36.5°C.

Oils have own refractive index so their refractive index were considered to identify oils and fats, discover any adulteration, and perceive their impurities. Refraction index is directly dependent on oil fatty acids such that the more unsaturated oil or the higher iodine value, the higher refraction index. Refraction index and iodine value of the manufactured sample are 1.4597 and 65.74 respectively. The most important characteristic of oils affecting their shelf-life is oxidation – resistance measured by Rancimate. Oxidation – resistance of the sample at 110°C was 18.25h.

Color is one of the most important attributes directly related to food acceptability. In addition, it is helpful when examining the quality of foods. The oil becomes exposed to oxygen, or at unsuitable temperature due to different reactions, especially oxidation, formation of different compounds was occur that affected the color of product. Thus examination of color properties of oil is enormous important. Red and yellow hue indices of the sample, measured by Laviband, were 4 and 3, respectively.

Heavy metal contamination requires special attention particularly with oils because bivalence metals such as iron and copper enhance oxidation reactions. Measurements of heavy metals are given in Table 2. The amounts of nickel, iron, copper, and arsenic were 0.01, 0.81, 0.01 and 0.05 respectively and all of them being within the range of national standard.

As stated above the presence of moisture in margarine may provide a favorable media for growth of different microorganisms. Microbiological measurements of S.oreus, E.coli, total count, mold and yeast demonstrated acceptable according to national standard.

Since oils provide essential fatty acids, they are biologically examined, thus, it is important to study their fatty acids profile. Another important issue is the formation of trans fatty acids, as they exert harmful effects on human health. Trans fatty acids are produced as a result of hydrogenation process. In food industries, this process is economical because it reduces the occurrence of oils rancidity and increases their shelf-life. However trans fatty acids are the most harmful fatty acids because they increase LDL and decrease HDL levels. In addition they increase the level of cholesterol and triglycerides of blood. Hydrogenation process is inevitable during margarine manufacture. However, trans fatty acids formation should be minimized by controlling the processing condition.

Fatty acids profile of the produced sample is given in Table 3. As shown in the Table 3, great parts of margarine consist of oleic, palmitic, and linoleic acids. Interestingly the amount of elaidic acid (oleic acid trans) was very small. Also total content of trans fatty acids in the sample was very insignificant (3.66). The results showed that the total trans and saturated fatty acids was 45.95. According to national standard, total trans fatty acids, saturated and trans fatty acids must not exceed 10 and 50 respectively. Therefore the results of current research is acceptable regarding trans fatty acids content.

Table 1- Formulation of produced table margarine

Ingredient	Table margarine
Salt	6600 g
Potassium sorbet	1950 g
Sodium benzoate	1050 g
Milk powder	25 kg
Mono glyceride	12 kg
Citric acid	900 g
Butter essence	750 g
Water phase	600 kg
Oil phase (75% palm olein-25% soybeen)	2400 kg
Total	3000 kg

Samadzadh *et al*., (2008) investigated about margarine that was produced by different producer in Iran, and reported that mean value of total trans fatty acid and total saturation fatty acid were 14.10 % and 31.79 % respectively. The total trans fatty acid and total saturation fatty acid of their samples were higher than current research that show, suitable condition of margarine process in this study.

Table 2- Physicochemical and microbial properties of the produced table margarine

Table margarine	Sample	Standard
Moisture (%)	19.09	Max 16
Peroxide value (meq/kg)	0.32	Max 2
Acidity (% oleic acid)	0.13	Max 0.30
Preservatives (sorbic and benzoic acids) (ppm)	515.93	Max 1000
Slip point	35.2	Max 37
Refraction index (40C)	1.4597	-
Iodine value	65.74	-
Resistance / h (Rancimate at 110C)	18.25	-
Laviband hue (Red)	4	-
Laviband hue (Yellow)	3	-
Nickel (ppm)	0.01	Max 1
Iron (ppm)	0.81	Max 1.5
Copper (ppm)	0.01	Max 0.1
Arsenic (ppm)	0.05	Max 0.1
S. aureus	Negative	Negative
E.coli	Negative	Negative
Total count	Allowed	Max 1000
Mold	<10	Max 10
Yeast	Allowed	Max 50
Coliform	<10	Max 10

Table 3- Fatty acids profile of table margarine

Fatty acids of table margarine	Control
C8	0.01
C10	0.01
C12	0.15
C14	0.77
C15	0.04
C15:1	-
C16	33.08
C16:1	0.19
C17	0.10
C17:1	0.03
C18	7.60
C18:1(t)	2.88
C18:1(cis)	36.48
C18:2(t)	0.75
C18:3(t)	-
C18:2(cis)	15.61
C18:3(gamma)	0.03
C18:3(alpha) (1.5 – 5)	1.5
C18:3(t)	0.03
C20	0.30
c20:1	0.13
C22	0.15
C24	0.08
Total trans (max 10)	3.66
Total trans and saturate (max 50)	45.95

CONCLUSION

Today, in most parts of world, people are increasingly consuming margarine made of vegetable fat instead of butter. Margarine commonly is produced using unsaturated vegetable oils such as soybean, canola, corn, sunflower, etc. and hydrogenated to improve consistency. Hydrogenation, results in saturation of some double bonds and unfortunately, it generates trans fatty acids which increase LDL and reduce HDL levels resulting in increased incidence of cardiovascular diseases. In recent years, researchers and scientists have focused on producing free or low-fat trans fatty acid margarine. The results of the present study showed that not only physicochemical and microbial properties of the produced sample are according to national standard also its trans fatty acids content was very low so production margarine based on palm and soybean oils is considered as a safe product.

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