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Production of industrial margarine with low tran's fatty acids and investigation of physicochemical properties

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ABSTRACT

In this study industrial margarine with low trans fatty acid was made based on soy and palm oils and its microbial and different physicochemical properties as well as fatty acids profile were investigated. Resistance to oxidation, iodine value, acid value and refraction index of this sample were 16.64 h, 65.25, 0.13%, and 1.4598, respectively. Heavy metal analysis showed that the sample was according to national standard. The results of current study showed that the main fatty acid was oleic acid (36.65 %) and its total trans fatty acids content was up to 3.37%.

INTRODUCTION

Oils play a crucial role in human nutrition. In addition to produce energy, they provide essential fatty acids regulate blood lipid content and are the solvents of fat – soluble vitamins as well as carriers of other compounds together with fats including carotenoid pigments and sterols. Oil used in making various foods also enhances the flavor. Thus they are widely used in different kinds of foods [1]. Consumption of vegetable oil, i. e. margarine has been increased due to urbanization phenomenon and increased occurrence of cardiovascular diseases. According to Iranian National Standard, margarine is a water–in–oil emulsion with oil phase being a mixture of permitted edible oils and water phase containing milk or its products or a mixture of them. Also low amounts of allowed edible ingredient such as salt, flavoring agent, emulsifier, antioxidant and vitamin are added to this product. Margarines supplied in global markets often show unsatisfactory quality for storage and different uses. So it requires some changes to obtain desirable quality and to extend shelf life. To do so, oils with different compositions as well as different processes such as hydrogenation, esterification, or a combination of them are applied [2]. During hydrogenation process, in spite of provided oil stability some essential fatty acids are eliminated. Relative hydrogenation results in formation of spatial isomers of double bands as well as Trans isomers. Harmful effects of trans fatty acids on human health have been demonstrated and caused some concern because these acids compete with essential fatty acids metabolism. Also their consumption has been associated with cardiovascular diseases increased LDL and lowered HDL level. In Iranian oil factories only hydrogenation is applied for manufacture of edible oils with house, confectionery etc [3]. The objective of this study was to investigate the production of edible tabel – industrial margarine with low transe fatty acid as well as its physicochemical and microbial properties .

MATERIALS AND METHODS

Materials

A kind of table margarine was produced using the formulation presented in Table 1. Potassium sorbat and citric acid were 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.

Process of margarine production

Oil phase of the prepared formulation is heated in a separate container reaching 5ºC above melting point of the emulsifier. Then the soluble matters in oil phase (emulsifier) are solved in the heated oil phase. In another container water soluble matters (salt, potassium sorbate, sodium benzoate, milk powder), with the values determined in the formulation are solved in some drinking water phase, temperature then reached 75ºC for 15 S and rapidly declined to about 35-40ºC by pasture system in order to pasteurize the water phase. Oil and water phases are transferred to a container equipped with a load cell with the ability of controlling weight then they are mixed resulting in formation of margarine emulsion. In this step sensitive matters such as citric acid essence and vitamins are added. Then they pass through perfect or system (Voteitor) by high – pressure pump (piston pump) and cooled by a refrigerant (ammonia) and then stored at 8-10ºC (figure 1).

Method analysis

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 analysis

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. Resistance was examined by use of rancimat according to National standard No. 7513. Microbial tests including mold and yeast, E. coli, staphylococcus oreus, and total count was performed according to national standard No. 10899-2, 6806-2, and 5272-, respectively.

RESULTS AND DISCUSSION

The results of physicochemical analysis of the produced industrial margarine are presented in Table 2. Applying the emulsifier in margarine manufacture allows the addition of high amount of water to the formulation. As shown in Table 2, the moisture content of final product is 19.95% allowing different microorganisms to grow in the product. Therefore certain amounts of salt and preservatives are used to prevent the organisms from growing. In our sample two preservatives sorbic and benzoic acids at 330.65 ppm are used. Iranian National standard has determined the acceptable value of this preservative up to 1000 ppm. This sample thus is within the standard range. As the results of microbial tests indicate bacteria including S.oreus and E.coli do not show any growth and total count yeast, coliform and mold meet the measures determined by Iranian National standard suggesting proper method of production as well as suitable amount of preservative used in the formulation. The presence of moisture in the formulation affects not only the microorganisms but chemical reactions as it increases oil hydrolysis as well as free fatty acids existing in the product. High amount of free fatty acids results in generation of off – flavors and rancidity. The acidity value of the produced sample is 0.13% being lower than of the highest value accepted by National standard. The most important reaction occurring in oils are the reactions associated with oxidation. It not only results in oil with low quality but also threatens the consumer's safety. To investigate the oil resistance to oxidation, Reanimate was used. It measures the oil resistance to oxidation through measuring the content of formic acid as a secondary product of oxidation. As indicated in Table 2 the resistance value of the produced sample is 16.64 h. Peroxide value is used to determine the amount of oxidized oil. Peroxide is among the primary products of oxidation which its high amount suggests the oil oxidation and undesirable quality. The peroxide value of the sample is 0.56 meq/kg being 0.1 of the highest value accepted by National Standard. The pigments of oil augment the oxidation reactions resulting in a dark color, i. e. they increase redness. The results of colorimetric analysis showed a low value of redness (0.60) for the product. There has been paid much attention to heavy metals contamination because some of these metals have been recognized as toxic compounds threatening the consumer's health. It is more important issue in oil industry since in addition to safety hazards they may augment oxidation reactions in oils. The amounts of Nickel, Iron, Copper and Arsenic in the produced sample are 0.01, 0.35, 0.1 and 0.005 ppm, respectively corresponding to National standards. The profile of fatty acids of the sample is presented in table 3. Since this margarine sample consist of two types of oil, palm olein and soybean at a ratio of 75 to 25 the predominant fatty acids are oleic (36.65), palmitic (33.15) and linoleic (15.30). In the process of margarine production hydrogenation is inevitable resulting in the generation of trans fatty acids. The low amount of trans fatty acids in the produced sample needs to be paid attention. Considering the important role of nutrition in human health the formulation of the sample include

the lowest amount of harmful trans fatty acids (<3%). To do so base oil of different kinds of palm has been used. Palm olein is insignificantly hydrogenated so that its refract value reduced only by 6 reaching to 1.4598 (Table 2) and its melting point reached to about 35ºC (table 2). Then soybean oil and palm stearin are added for adjustment of melting point. Given the fact that most Trans fatty acids are generated through hydrogenation, insignificant level of this process results in generation of very low amount of trans fatty acids (3.37%). Samadzadh *et al.*, (2008) studied about margarine that was produced by different producer in Iran, and reported that mean value of total trans fatty acid was 14.10 % that was very higher than current study.

Table 1- Formulation of produced industrial margarine

Ingredient	industrial margarine
Salt	6600 g
Potassium sorbet	1950 g
Sodium benzoate	1050 g
Mono glyceride	12 kg
Citric acid	900 g
Butter essence	400 g
Water phase	600 kg
Oil phase (75% palm olein – 25% soybeen)	2400 kg
Total	3000 kg

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

Industrial margarine	Sample	Standard
Moisture (%)	19.95	-
Peroxide value (meq/kg)	0.56	Max 5
Acidity (% oleic acid)	0.13	Max 0.3
Preservatives (sorbic and benzoic acids) (ppm)	330.65	Max 1000
Slip point	35.4	Max 44
Refraction index (40C)	1.4598	-
Iodine value	65.25	-
Resistance / h (Rancimate at 110C)	16.64	-
Laviband hue (Red)	0.60	-
Laviband hue (Yellow)	6	
Nickel (ppm)	0.01	Max 1
Iron (ppm)	0.35	Max 1.5
Copper (ppm)	0.1	Max 0.1
Arsenic (ppm)	0.005	Max 0.1
S. oreus	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 of industrial margarine

Fatty acids of margarine	Control
C8	0.01
C10	0.01
C12	0.14
C14	0.75
C15	0.04
C15:1	0.01
C16	33.15
C16:1	0.19
C17	0.10
C17:1	0.03
C18	7.89
C18:1(t)	2.69
C18:1(cis)	36.65
C18:3(t)	0.65
C18:2(cis)	15.30
C18:3(gamma)	0.03
C18:3(alpha)	1.45
C18:3(t)	0.03
C20	0.35
c20:1	0.14
C22	0.18
C24	0.10
Total trans (max 10)	3.37

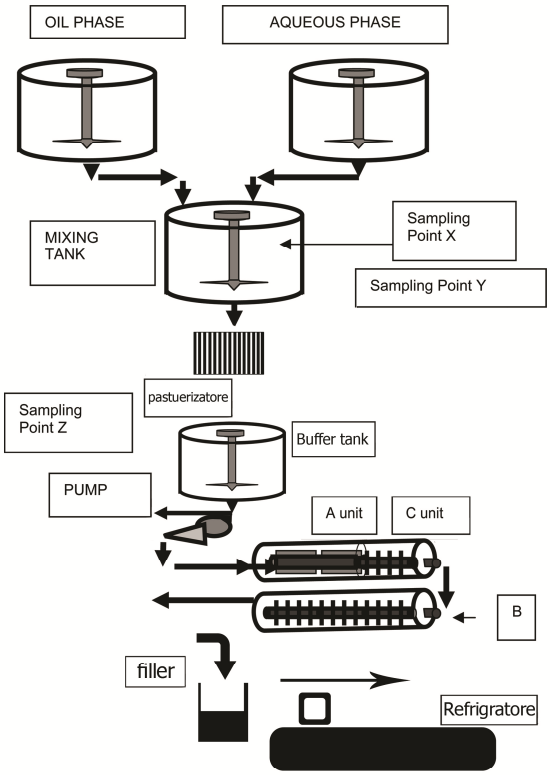

Fig1.flow diagram for margarine production

CONCLUSION

Given the urbanization and modernization phenomena and increase in cardiovascular diseases the consumers show a rising tendency towards consumption vegetable oils such as margarine. In this study has tried to optimize the formulation and conditions under which industrial margarine is manufactured there by producing a high quality product with a low amount of Tran's fatty acids corresponding to standard.

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