UTILISATION OF SUNFLOWER OIL IN COMBINATION WITH SELECTIVELY HYDROGENATED FATS IN MAKING EDIBLE PLASTIC FATS BY MISCELLA INTERESTERIFICATION PROCESS.

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Abstract

The miscella interesterification process conditions have been studied for sunflower oil mixed with some selectively hydrogenated fats in order to examine the scope of producing plastic fats of specific properties and edible uses. The study shows on the basis of the characteristics of the products that sunflower oil can be used to the extent of 40% along with hydrogenated mowrah (Madhuca Latifolia), hydrogenated palm and hydrogenated rice bran in making vanaspati and margarine with varying poly unsaturated fatty acids.

Introduction

It is usually difficult to convert sunflower oil because of its very high linoleic acid content into plastic fats of 35°C to 37°C melting slip points by interesterification process unless the oil is blended with appropriate saturated acids rich fats in suitable proportions. Instead of natural hard fats, partially hydrogenated fats of slip points about 37°C to 43°C can be mixed with sunflower oil which on interesterification can help in the preparation of plastic fats of melting range close to those of hydrogenated vanaspati.

The use of hydrogenated fat such as hydrogenated palm, hydrogenated mowrah and hydrogenated rice bran in sunflower oil in suitable proportions during interesterification reaction of both random and directed types is considered to be quite useful and important raw material instead of the corresponding unhydrogenated fat in making plastic fats for use as food fats like vanaspati and margarine.

The present study aims at investigating interesterification reaction of sunflower oil mixed with hydrogenated fat like hydrogenated palm, hydrogenated mowrah and hydrogenated rice bran in the miscella stage in order to obtain information about melting slip points and dilatation characteristics of the interesterified fat products for consideration of use as substitute of hydrogenated vanaspati and also as margarine fats.

It may be stated that the interesterification reaction of sunflower oil in the miscella stage admixed with hydrogenated fat like hydrogenated palm, hydrogenated mowrah and hydrogenated rice bran does not appear to have been investigated for making plastic fats for the purpose as stated earlier.

Materials and methods

The purified oils (acid value of about 0.05 and peroxide free) were blended in various proportions. The interesterification reaction of the different sunflower blends was carried out by using sodium methoxide catalyst in the presence of hexane as the solvent according to the method reported from the laboratory (CHAKRABARTY et al., 1968). The initial randomisation reaction was carried out by continuous stirring of a 60% solution of oil blend in hexane for half an hour with 0.4% of sodium methoxide catalyst(30% NaOMe in anhydrous methanol). Thereafter, the products were subjected to various low temperatures for different lengths of time to complete the directed interchange. The catalyst was destroyed with dilute phosphoric acid and the excess acid removed by washing with distilled water. The solvent was distilled off and the product was finally isolated by drying on heating under vacuum. Products were examined for slip points, dilatation and glyceride composition.

The slip points of the prepared fats were determined after proper stabilisation of $0^{o} \pm 1^{o}C$ for 24 hours. Methyl esters of the oil under investigation were prepared by the method (METCALFE, 1966). The fatty acid compositions were determined by Gas-Liquid-Chromatography.

The solid fat index (ml/Kg) was calculated from dilatation values for selected samples (35^{o} - $40^{o}C$) according to the standard procedure (BOEKENOOGEN, 1964) and glyceride composition by oxidation (YOUNG, 1961) and titrimetrically (ADHIKARI et al, 1981).

Results

The fatty acid composition of the oils investigated is shown in Table-1. The melting slip points, glyceride composition and solid fat index of the various interesterified sunflower oil blends are included in tables 2 & 3.

Table-1 FATTY ACID COMPOSITION OF THE OILS/FATS

Oil/Fat	Slip Point (^{o}C)	Fatty Acid composition, % (w/w) $C_{14:0}$	$C_{16:0}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{20:0}$	Trans %
Sunflower	$0^{o}C$	-	8.1	4.1	42.4	45.4	-	-
Hydrogenated mowrah	43	0.4	25.1	21.0	45.7	7.9	-	36.2
Hydrogenated palm	43	0.6	37.5	9.3	44.7	7.9	-	35.8
Hydrogenated R.B.O.	37.5	-	16.6	7.4	59.4	15.4	1.0	38.6

TABLE - 2

INTERESTERIFICATION OF BINARY MIXTURES OF SUNFLOWER OIL WITH HYDROGENATED FATS

Oil mixture	Random-isation	Directed Temp. °C ± 1°C	Directed Time (hr.)	Slip Point (°C)	Triglyceride Composition % (W/W) GS_3	GS_2U	GSU_2	GU_3
Sunflower + Hydrogenated Mowrah (40:60)	Randomised	-	-	28				
Sunflower + Hydrogenated Mowrah (40:60)	-do-	5±15	3±3	35.5-36	6.0	18.4	39.6	36.0
Sunflower + Hydrogenated Mowrah (40:60)	-do-	5±10	2±2	34.5-35	5.8	18.0	40.9	35.3
Sunflower + Hydrogenated Mowrah (50:50)	-do-	5	24	36	5.7	15.9	38.4	40.0
Sunflower + Hydrogenated Mowrah (30:70)	-do-	-	-	32				
Sunflower + Hydrogenated Mowrah (30:70)	-do-	5±15	3±3	37	7.3	22.4	39.4	30.9
Sunflower + Hydrogenated Mowrah (30:70)	-do-	5±15	2±2	36.5	7.1	21.5	40.7	30.7
Sunflower + Hydrogenated Mowrah (30:70)	-do-	15	6	35	6.4	22.2	42.0	29.5
Sunflower + Hydrogenated Mowrah (30:70)	-do-	5±15	1±1	35.5	6.8	21.1	42.4	29.8
Sunflower + Hydrogenated Mowrah (40:60)	-do-	-	-	28				
Sunflower + Hydrogenated Palm (40:60)	-do-	5	24	35	5.9	19.1	40.1	35.0
Sunflower + Hydrogenated Palm (30:70)	-do-	5±15	3±3	35	7.6	22.7	38.4	31.3
Sunflower + Hydrogenated Palm (20:80)	-do-	5±15	2±2	36	8.3	26.4	39.0	2633
Sunflower + Hydrogenated Rice-Bran (40:60)	-do-	-	-	25.5				
Sunflower + Hydrogenated Rice-Bran (40:60)	-do-	5	24	35				
Sunflower + Hydrogenated Rice-Bran (30:70)	-do-	5	24	33				

TABLE - 3

SOLID FAT INDEX OF SOME INTERESTERIFIED FAT PRODUCTS OBTAINED FROM BINARY MIXTURES OF SUNFLOWER OIL AND HYDROGENATED FATS

PRODUCTS	Slip point (°C)	Solid fat Index (ml/kg.) 15°C	20°C	25°C	30°C	35°C	40°C
Sunflower + Hydrogenated Mowrah (40:60) Directed interesterified (D.I.) 5°±1°C/3 hrs. + 15°±1°C/3 hrs.	35.5-36	15.2	11.3	8.2	4.7	0.7	-
Sunflower + Hydrogenated Mowrah (40:60) (D.I.), 5°±1°C/2 hrs.+15°±1°C/2 hrs.	35.5-36	15.8	11.6	8.4	5.1	0.9	-
Sunflower + Hydrogenated Mowrah (50:50) (D.I.), 5°±1°C/24 hrs.	36	13.6	11.2	8.8	5.4	2.7	0.5
Sunflower + Hydrogenated Mowrah (30:70) (D.I.), 5°±1°C/3 hrs.+15°±1°C/3 hrs.	37	20.7	15.8	11.9	6.9	1.5	-
Sunflower + Hydrogenated Mowrah (30:70) (D.I.), 5°±1°C/2 hrs.+15°±1°C/2 hrs.	36.5	20.9	16.0	11.9	6.9	1.5	
Sunflower + Hydrogenated Mowrah (30:70) (D.I.), 5°±1°C/6 hrs.	35	20.1	15.4	11.7	7.0	1.6	-
Sunflower + Hydrogenated Mowrah (30:70) (D.I.), 5°±1°C/1 hr.+15°±1°C/1 hr.	35.5	20.6	16.1	11.9	6.9	1.7	-
Sunflower + Hydrogenated Mowrah (40:60) (D.I.), 5°±1°C/24 hrs.	35-35.5	17.8	15.4	11.3	7.0	2.0	-
Sunflower + Hydrogenated Palm (30:70) (D.I.), 5°±1°C/3 hrs.+15°±1°C/3 hrs.	35	19.1	14.8	10.7	5.6	0.7	-
Sunflower + Hydrogenated Palm (20:80) (D.I.), 5°±1°C/2 hrs.	36	24.1	19.3	14.0	8.6	2.4	0.7

Discussion

It can be observed from Table-2 that unless directed interesterification reaction is conducted it is not possible to obtain plastic fats of desired melting slip points 35°C to 37°C even though sunflower oil was mixed with a hydrogenated fat. The directed interesterification reaction conditions were important for obtaining desired melting points. The amount of hydrogenated fat used in the blend was also important controlling factor of the course of interesterification reaction. Thus sunflower oil containing 60% hydrogenated Mowrah, on randomisation yielded a product of 28°C slip point and when directed at 5°± 1°C for 6 hrs. the slip point of the product became 34°C. When the same blending was directed at 5°± 1°C for 2 hrs. and then at 15°± 1°C for another 2 hrs. or at 5°± 1°C for 3 hrs. and then at 10°± 1°C or 15°± 1°C for another 3 hrs., products of slip points of 35°C to 36°C could be obtained. If the percentage of hydrogenated mowrah was reduced by 10% in the combination (Sunflower : Hydrogenated mowrah = 50:50) a directed interesterification reaction for a period of as high as 24 hrs. at 5°± 1°C was needed to obtain a product of 36°C slip point. When sunflower oil was blended with 70 parts of hydrogenated mowrah and randomised a product of slip point of 32°C was obtained. When this combination was directed at combined temperatures e.g. at 5°± 1°C for 3 hrs. and then at 15°± 1°C or 10°± 1°C for another 3 hrs. or at 5°± 1°C for 1 to 2 hrs. it became possible to get products of slip point from 35°C to 37°C. The above blending (Sunflower : Hydrogenated mowrah = 30:70) when directed at 15°± 1°C for 6 hrs. was converted to a product of slip point of 35°C.

From Table-2, it can be stated that sunflower oil when blended with hydrogenated palm instead of hydrogenated mowrah in the ratio 40:60 and randomised, the product had the same slip point (28°C). Also the directed interesterification reaction at 5°± 1°C for 3 hrs. and then at 15°± 1°C for another 3 hrs. of this blend produced products of the desired but similar slip point. When sunflower oil was blended with 70% hydrogenated palm, a product of slip point of 30.5°C - 31°C was obtained by randomisation. On directed interesterification of this blend at 5°± 1°C for 3 hrs. and then at 15°± 1°C for another 3 hrs. it was possible to obtain products of same melting slip point of 35°C. When the percentage of hydrogenated palm was further increased by 10% (Sunflower : Hydrogenated palm = 20:80) even the randomisation is inadequate to yield product of the desired melting slip point. It was again necessary to carry out the directed reaction at 5°± 1°C for 2 hrs and then at 15°± 1°C or 10°± 1°C for another 2 hrs. to get a product of slip point of 36°C as evident from Table-2. As regard the hydrogenated rice bran and sunflower blend, it could be noted that the maximum slip point of the product was only 35°C.

The directed interesterification reaction produced products of high slip points (35°C to 42°C) due to the increased formation of GS_3 in the interesterified products. There was always the formation of high amount of GU_3 in the interesterified products irrespective of the conditions of the reaction and the nature of blends. The proportion of GS_2U varied significantly for each fat

blend depending on the conditions, temperature and time. In general, it dicreased during randomisation and directed interesterification reaction. The proportion of GSU_2, in general, decreased for each fat blend with the progress of directed interesterification reaction.

From Table-3, it could be seen that for different interesterified fats obtained from the blends of sunflower oil with other hydrogenated fats, the solid fat index decreased as the percentage of sunflower oil increased in the blends whatever may be the slip point of the product. The interesterified fat products obtained from sunflower oil with other hydrogenated fats showed higher solid fat index than those obtained from sunflower oil and other vegetable oils. This could be explained by the occurrence of trans unsaturated acids in the hydrogenated fats and, to an extent, by the total amount of stearic acid which was somewhat more in the hydrogenated fats. These interesterified fat products resembled very closely natural ghee (butter fat anhydrous).

The miscella interesterification reaction of sunflower oil with hydrogenated palm and hydrogenated mowrah was important as plastic fats of desired melting slip point (35°C to 37°C) could be obtained from their different blendings. The interesterified products could be much better used in the preparation of margarines of low trans-isomers and higher linoleic acid as required for better nutrition.

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