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Development of some bioactive food compounds based soy spreads

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ABSTRACT

This study demonstrates the development of Soy Spreads enriched with bioactive compounds such as new kinds of antioxidants namely Oryzanol from RBO and Lignan from Sesame oil which are absent in Soy Spread and more balanced fatty acids in respect of MUFA and PUFA ratios. The Soy Spreads with the incorporation of RBO, Sesame oil and mixture of both the oils indicate the means of producing nutritionally valuable foods with health benefits. The market Soy Spread and the different Soy spreads made have been evaluated for their physicochemical, microbiological, sensorial and nutritional properties. The proximate composition shows similar amount of carbohydrate and protein but decreased fat content(39%) in case of the enriched Soy Spreads as compared to the market Spread(45%).The mineral content increased from 1% (Market Spread) to 4% (Enriched Soy Spread).The microbial and sensorial study show good acceptability of the different bioactive compounds-based Soy Spreads.

Keywords: Soy Spread, RBO, Sesame oil, Oryzanol, Lignan

INTRODUCTION

Soy butter is conventionally made from roasted, whole soy nuts which are then crushed and blended with soybean oil and other ingredients. Soy butter prepared from the Soy nuts is a healthier alternative of the dairy spread comprising the goodness of 'complete protein' with balanced amino acid profile along with cardio-protective oil property due to high amount of PUFA (w_3 fatty acid) and low amount of saturated fat. Soy butter supplies all nine essential amino acids along with bioactive compounds such as Isoflavone, genistein and daidzein and provides many functional benefits to the food processors [1]. Soy butter provides good amount of minerals (Ca, Fe, Mg, P, Zn) and natural antioxidant Vitamin E along with promoting moisture and flavor retention, aid emulsification, and also enhances the texture of many foods as well as offers better digestibility.

Soy food utilization around the world varies widely. Soybeans in food applications became very popular after a soy protein health claim was approved in October 1999 by the United States Food and Drug Administration [2]. Protein is the second major chemical component of soybeans that has commercial value due to its amino acid composition. Soy protein promotes emulsion formation due to the presence of both hydrophobic and hydrophilic regions [3].

Some scientists have suggested that a positive association existed between high intake of soybean products and a low risk of cancer in some organs, such as the breast, prostate and colon [4, 5].

Functional foods have become a means of delivering beneficial components in the human diet. As the functional food market continues to grow, surveys indicate consumers wish soy to be incorporated into food. Soybeans have a relatively high amount of lysine and can provide all of the essential amino acids required for children and adults [6]. Soy lacks in natural antioxidant content and it contains significantly greater amount of w_6 fatty acid (w_3 : w_6=1:7) and Soy oil is very susceptible to oxidation [7].

The nutritional properties of the conventional Soy butters are being envisaged to enhance by taking advantages of certain vegetable oils (RBO and Sesame oil) that are characterized for having well balanced fatty acid composition and antioxidants responsible for cholesterol lowering effect.

There are numerous reports on the anti-hypercholesterolemic effects of vegetable oils rich in polyunsaturated fatty acids. RBO is mainly consumed in Asia as an alleged "healthy oil" [8]. It is considered to be on the higher end of quality vegetable oils in terms of its cooking stability, shelf life, and fatty acid composition. RBO contains oleic and linoleic acids as the major unsaturated fatty acids, and palmitic acid as the major saturated fatty acid. The high oxidative stability of RBO can be attributed to the presence of phenolic compounds such as γ -oryzanol, with functions similar to those of vitamin E and tocotrienols [9, 10]. Recently, interest in RBO was generated due to its nutritional value, showing cholesterol lowering effects and antioxidant activity. Such effects can be attributed to the presence of γ -oryzanol, tocotrienols, and phytosterols. RBO has been used for its functional and nutritional properties to develop zero-trans fat shortening [3].

Sesame paste has remarkable oil stability and resistance to oxidative deterioration and does not require refrigeration to minimize oxidation. This resistance to oxidation is due to endogenous antioxidants (sesamol and sesaminol) together with tocopherols. These two lignans are liberated from sesamolin by heating and subsequent storage of raw oil [11, 12, 13].

The objective of the present study is to develop certain Soy spread products that will be enriched with bioactive compounds like antioxidants and trace elements which are unavailable in Soy Spreads and also comprising more balanced oil phase for boosting the product with desired kind of fatty acid composition giving special emphasis on MUFA and PUFA ratio.

MATERIALS AND METHODS

Chemicals and reagents

Soybean , RBO (Sethia oil mill, Burdwan, West Bengal) , Sesame oil, Honey (Dabur), Salt (Iodised Tata salt) were purchased from local market (Kolkata, India).

Monoglyceride, Sodium benzoate and all other chemicals used are from Merck, India.

Soy Spread:

A commercial Soy Spread (a standard product made from *Glycine max*) was purchased from market.

Preparation of Bioactive Compounds Enriched Soy Spreads:

Preparation of Soy Flour:

Soybeans were boiled in 0.5 % sodium bicarbonate solution for 45 min, washed in cold water and hand rubbed to aid removing the hulls. Dehulled soybeans were then dried in a forced air oven at 70 °C, placed in glass jars and stored at 15 °C .The soybeans were afterwards brought to room temperature, placed in rotary roaster at 100 °C for 45 min and roasted. Then roasted seeds were grinded in mixer (Bajaj,GX10) to get whole flour.

Preparation of Rice Bran Oil incorporated Soy Spread: All dry ingredients including soy flower, salt, Sodium benzoate and Monoglyceride were passed through 65 mesh screen to attain desired particle size. The liquid phase containing RBO and honey were uniformly homogenized with the solid phase by using a glass homogenizer (Remi Motors, CPUC 3006) to obtain a smooth spread like product. The product was stored in food grade plastic container at 10° C.

Preparation of Sesame Oil incorporated Soy Spread: All dry ingredients including soy flower, salt, Sodium benzoate and Monoglyceride were passed through 65 mesh screen to attain desired particle size. The liquid phase

containing Sesame oil and honey were uniformly homogenized with the solid phase by using a glass homogenizer (Remi Motors, CPUC 3006) to obtain a smooth spread like product. The product was stored in food grade plastic container at 10 °C.

Preparation of RBO and Sesame oil incorporated Soy Spread: All dry ingredients including soy flour, salt, Sodium benzoate and Monoglyceride were passed through 65 mesh screen to attain desired particle size. The liquid phase containing RBO and Sesame oil and honey were uniformly homogenized with the solid phase by using a glass homogenizer (Remi Motors, CPUC 3006) to obtain a smooth spread like product. The product was stored in food grade plastic container at 10° C.

Ingredient composition of different Bioactive Compounds enriched Soy Spreads prepared:
The variant vegetable oils used as a fat phase in the different enriched Soy Spreads prepared was 27g Rice Bran Oil (RBO), 27g Sesame Oil (SES) and a mixture of 13.5g Rice Bran Oil and 13.5g Sesame Oil (RBSES). Other ingredients which were common to all preparations were 63g whole Soy flour, 8g honey, 1.5g common salt, 0.4g Monoglyceride and 0.1g Sodium Benzoate. (Current usage of Sodium Benzoate results in a maximum level of 0.1 percent in food; FDA, April 1, 2012)

The products have been categorized as:
MS = Market Soy Spread (Control)
RBS = RBO incorporated Soy Spread
SES = Sesame Oil incorporated Soy Spread
RBSES = RBO and Sesame oil incorporated Soy Spread

Product Analysis
Chemical Analysis
Proximate composition: The analysis of the samples for moisture, fibre and ash content were carried out in triplicate using standard methods [14]. Carbohydrate was determined according to Anthrone reaction method and determination of protein was done by Folin Lowry method [14]. Energy values were obtained using the Atwater formula where fat, protein, and carbohydrate supplied were 9, 4, 3.75 Kcal/g respectively [15].

Determination of Fat content:
Fats were determined by Soxhlet method [16]. 50g of the samples were placed into a cellulose paper cone and extracted using n-hexane in a Soxhlet extractor for 8 h. The n-Hexane was distilled off and finally removed completely by applying vacuum. The weight of the recovered oil was taken.

$$\text{Fat content (\%)} = \frac{\text{Amount of fat extracted (g)}}{\text{Weight of original sample (g)}} \times 100$$

Fatty acid composition (%w/w) of the oils isolated from Soy Spreads:
Pure triglyceride fraction was separated from the isolated spread fat by thin layer chromatography on silica gel G layer, with 90 volume n-hexane and 10 volume diethyl ether mixture as the eluting solvent. The triglyceride fraction identified by exposure to iodine vapour , marking the spot and removing iodine by aeration and extracting the triglyceride spot with n-hexane several times. The hexane was evaporated off and the triglyceride fraction isolated was methylated to methyl esters by the method of Brockerhoff [17]. The conversion of triglyceride to fatty acid methyl esters suitable for Gas Liquid Chromatography analysis is accomplished by one of the simplest KOH catalyzed methanolysis method of Brockerhoff. About 40 mg of triglyceride was dissolved in 0.5 ml of diethyl ether and 1ml of 0.5 (N) methanolic KOH solutions was added and shaken. After 10 minutes at room temperature 1ml of 1(N) HCl was added and shaken. The methyl esters were extracted with 3x1.0 ml of petroleum ether. The extracts were evaporated in water bath. The sides of the tube were washed with sufficient GLC grade n-hexane to redissolve the methyl esters for GLC analysis.

Mineral estimation:
Ashing of the different Soy Spread samples was done. 0.5 g of each ash sample was digested first with concentrated nitric acid and then with concentrated perchloric acid. It was then filtered and volume was made up to 50 ml. This solution was analysed by using Varian Spectra AAS (Model: AA 55).

Oryzanol estimation:
Gamma oryzanol content (%) in oils extracted from soy spreads were determined from spectrophotometer absorption measurements at the wavelength of maximum absorption near 315nm. Approximately 0.02g of the sample was weighed accurately into a 25mL volumetric flask, it was then made up to the mark with n-hexane. Cuvette was filled with the solution obtained and measured the extinction at the wavelength of maximum absorption near 315nm, using the same solvent as a reference. Oryzanol percentage was calculated according to the formula.

Gamma oryzanol content, % = 25 × (1 / W) × A × (1 / E)

Where W = mass of sample (g)
A = extinction (absorbance) of the solution
E = specific extinction E1%1cm = 359

Lignan estimation:
Oil soluble lignan was estimated using two different wavelengths-Sesamin was estimated at 278 nm and Sesamolin was estimated at 282 nm.

Detection of Isoflavone content [18] :
Isoflavones can be detected like the Flavones by two absorption bands at 333-350 nm and 250-270 nm and by characteristic Yellow colour with aqueous NaOH and Yellow to Orange colour with concentrated H_2SO_4.

Apparent Viscosity of Soy spreads (cP) and penetration:
Viscosity was based on measuring resistance to a rotating spindle (Spindle No 3 at 20 rpm) Brookfield Model DV-E Viscometer at constant temperature (25°C) for 5 min. Samples were allowed to relax (more than 10 min) prior to measuring their Viscosity. Viscosity measurements were expressed in centipoises (cP) performed in triplicate. The Viscosity determined with the Brookfield viscometer is known as the Brookfield Viscosity. The firmness of Spreads was determined by a Penetrometer (Stanhope-Seta Surrey, England) using the cone-form penetration body with an apical angle of 45°C, and a weight of 72.5 g. The depth of penetration was measured at 5 s at a product temperature of 25°C.

Microbiological Analysis:
The total microbial loads of the Soy spread samples were enumerated in freshly prepared zero and 7 days of cold storage at 10^oC as described by APHA (2005) [19]. Microbiological quality of market Soy Spread and different enriched Soy Spread samples made were evaluated by enumerating total viable organisms which include total aerobic count of bacteria, *E.coli*, total coliforms, yeast and molds.

Ten grams of Soy Spread samples were homogenized using CM 101 CYCLO MIXER (REMI) vortex stirrer with 90 ml sterile saline (0.85% NaCl) to obtain a 10^{-1} dilution. Further tenfold serial dilutions were made using the same diluents till a dilution of 10^{-8} was obtained. The spread plate technique was used to assess the microbial population. Aliquot (0.1 ml) of suitable dilution was spread plated in duplicates onto prepared, sterile and dried petridishes of suitable media for the enumeration of different organism. Plate count agar was used for total viable count and Potato Dextrose Agar was used for the presence of yeasts and moulds. After inoculating, the plates were agitated, allowed to solidify, incubated and inverted in an incubator at 37^oC for 48 hrs±2 for total viable counts and at 25^oC for 3-5 days for yeasts and moulds. The number of colonies counted on the plates taken into consideration the dilution factor and expressed as $\log_{10}$cfu/ml. Microbiological examinations were carried out at 1 and 7day of intervals.

Shelf life characteristics of spread products based on Peroxide value and Free fatty acid determination:
The fat was isolated from the different Soy Spreads and analysis was done in terms of Peroxide value and free fatty acid formation during seven days storage by standard Pearson method, 1970 [20].

Sensory evaluation of different Soy Spreads:
The Soy Spread samples were kept at 10^0C until evaluation. 20 members were chosen from the department of School of Community Science and Technology, BESU, Shibpur, Howrah, West Bengal**.** Evaluation was done at Nine Point Hedonic Scale. Characteristic evaluation included odour, taste, texture and overall acceptability. The information contained on the sensory performance was indicated as **9 =** like extremely,8 = like very much7= like

moderately 6= like slightly,5= neither like or dislike,4= dislike slightly,3= dislike,2= dislike very much,1= dislike extremely.

Statistical Analysis:
Statistical analysis was performed by using One Way Analysis of Variance (ANOVA). All analyses were carried out in triplicate (n=3). The means were compared across the groups by Tukey Test. All results were analysed with Origin Pro 8 and the significant differences were determined at $p<0.05$.

RESULTS AND DISCUSSION

The Control Soy Butter and various enriched Soy Spreads have been analysed depending on their physicochemical, microbiological and sensory evaluation while storing the products at 10^{o}C.

Chemical Properties:
The Market Soy Spread product and the different enriched Soy Spreads prepared in the present study have been analysed for proximate composition and the results are included below in **Table 1**.

Table 1: Chemical Composition of Market Soy Spread (control) and Bioactive Compounds Enriched Soy Spread products (n=3)

Parameters	MS	RBS	SES	RBSES
Chemical Composition				
Carbohydrate (g)	24.0 ± 0.08^{a}	21.7 ± 0.47^{c}	22.2 ± 0.50^{b}	21.4 ± 0.50^{d}
Protein (g)	25.0 ± 0.23^{a}	24.3 ± 0.47^{a}	25.0 ± 0.18^{a}	24.5 ± 0.45^{a}
Fat (g)	45.1 ± 0.37^{a}	39.5 ± 0.57^{c}	40.0 ± 0.17^{b}	40.0 ± 0.40^{b}
Fibre (g)	2.0 ± 0.34^{d}	2.6 ± 0.16^{b}	2.8 ± 0.07^{a}	2.4 ± 0.30^{c}
Ash (g)	1.0 ± 0.19^{d}	4.0 ± 0.34^{b}	3.9 ± 0.14^{c}	4.1 ± 0.14^{a}
Moisture (g)	3.0 ± 0.22^{d}	4.5 ± 0.35^{a}	4.3 ± 0.28^{c}	4.4 ± 0.34^{b}
Energy (kcal)	596.7 ± 4.22^{a}	535.0 ± 1.80^{d}	543.8 ± 4.09^{b}	539.3 ± 2.22^{c}
Fatty Acid Profile of oil isolated from Soy Spreads (%w/w) (n=3)				
16:0	13.4 ± 0.42^{b}	17.0 ± 0.12^{a}	10.9 ± 0.06^{c}	10.9 ± 0.07^{c}
18:0	5.4 ± 0.11^{c}	4.0 ± 0.12^{d}	5.5 ± 0.58^{b}	7.1 ± 0.10^{a}
18:1	29.1 ± 0.25^{d}	39.0 ± 0.44^{a}	38.1 ± 0.02^{c}	38.3 ± 0.22^{b}
18:2	46.2 ± 0.31^{a}	37.5 ± 0.41^{d}	42.5 ± 0.47^{b}	41.4 ± 0.10^{c}
18:3	5.5 ± 0.12^{a}	2.2 ± 0.10^{b}	1.6 ± 0.09^{d}	1.9 ± 0.07^{c}

Results have been expressed as mean ±SD (n=3).
Mean Values having different superscript letter in rows are significantly different ($p<0.05$). Values having same superscript letter in rows are not significantly different ($p<0.05$).
***MS** = Market Soy Spread (Control), **RBS** = RBO incorporated Soy Spread, **SES** = Sesame Oil incorporated Soy Spread, **RBSES** = RBO and Sesame oil incorporated Soy Spread*

The proximate composition in terms of chemical properties like protein and carbohydrate contents are similar to that of the control Soy Spread. The prime objective of making RBO and Sesame oil incorporated Soy Spreads was to enhance their nutritional value.

Table 2: Micronutrient content of Market Soy Spread (control) and Bioactive Compounds Enriched Soy Spread products (n=3)

Micronutrients	MS	RBS	SES	RBSES
Mineral Content (mg/100g)				
Iron	4.0 ± 0.16^{d}	10.0 ± 0.16^{b}	9.8 ± 0.26^{c}	10.1 ± 0.15^{a}
Copper	-	0.38 ± 0.026^{a}	0.37 ± 0.020^{a}	0.36 ± 0.020^{a}
Zinc	-	3.1 ± 0.11^{a}	2.9 ± 0.06^{a}	3.1 ± 0.06^{a}
Oryzanol and Lignan Content				
Oryzanol %	-	0.28 ± 0.052^{a}	-	0.14 ± 0.049^{b}
Lignan %	-	-	0.95 ± 0.047^{a}	0.50 ± 0.015^{b}

Results have been expressed as mean ±SD (n=3).
Mean Values having different superscript letter in rows are significantly different ($p<0.05$). Values having same superscript letter in rows are not significantly different ($p<0.05$).
***MS** = Market Soy Spread (Control), **RBS** = RBO incorporated Soy Spread, **SES** = Sesame Oil incorporated Soy Spread, **RBSES** = RBO and Sesame oil incorporated Soy Spread*

The fatty acid composition in Table 1 indicates that there is a subsequent rise in the oleic content of the enriched Soy Spreads made as compared to the market Soy Spread. This can act as a helpful vehicle in lowering the cholesterol

level and increasing the HDL cholesterol in blood. The decrease in the linolenic content in the enriched Soy Spread may be overruled by the beneficial effect of oryzanol and lignan.

Table 2 shows that the different enriched Soy Spreads contain increasing levels of micronutrient content in terms of Iron, Copper and Zinc which enhances the nutritional value as well as plays a role in providing good stability as compared to the market Soy Spread.

Incorporation of RBO provides Oryzanol (0.8g/100g oil), Tocopherol, Tocotrienol, Squalene which enhances the stability along with providing balanced Fatty acid composition. Sesame oil enhances oleic amount with the addition of Sesamol , Lignan (**Table 2**). It is well documented that sesame oil contains phenolic antioxidants (lignans) and tocopherols, almost completely in the form of γ-isomer, and these act synergistically to enhance the antioxidant property of sesame oil.

Presence of Isoflavones has been detected by UV Spectrophotometric absorption and colour reaction which shows enhanced percentage occurrence in Bioactive compounds enriched Soy Spreads compared to Market Soy Spread.

Physical Properties

Table 3: Physical Properties of Market Soy Spread (control) and Bioactive Compounds Enriched Soy Spread products (n=3)

Physical properties	MS	RBS	SES	RBSES
Penetration at 25° C ($1/10^{th}$ mm	283.6 ± 0.57^{c}	282.3 ± 1.15^{d}	291.0 ± 1.0^{a}	288.0 ± 1.73^{b}
Brookfield Viscosity in Centipoise at 25° C	85783.6 ± 2.30^{d}	91391.6 ± 1.52^{a}	90701.0 ± 1.73^{b}	89953.3 ± 2.88^{c}

Results have been expressed as mean ±SD (n=3).

Mean Values having different superscript letter in rows are significantly different ($p<0.05$). Values having same superscript letter in rows are not significantly different ($p<0.05$).

***MS** = Market Soy Spread (Control), **RBS** = RBO incorporated Soy Spread, **SES** = Sesame Oil incorporated Soy Spread, **RBSES** = RBO and Sesame oil incorporated Soy Spread*

The viscosity study at 25^0C shows almost similar kind of data like Control Soy butter (85,785 centipoises), Soy spread with RBO(91,392 centipoises), Soy spread with Sesame Oil (90,700centripoises), Soy spread with RBO and Sesame oil (89,955 centipoises).

The penetration study shows almost resembling nature of penetration like Control Soy butter (284mm/10), Soy spread with RBO (283 mm/10), Soy spread with Sesame Oil (292 mm/10), Soy spread with RBO and Sesame oil (289 mm/10).

Microbial Shelf life

As it is important, the microbial analysis of Market Soy Spread (control) and the different Bioactive Compounds enriched Soy Spreads were evaluated at zero day and after seven days of storage at 10° C. The result thus obtained shows that total aerobic bacteria and fungi (yeasts and mould) were not detected in the freshly prepared samples while in the samples after seven days of storage at 10° C, the total plate count (total aerobic bacteria) and the fungal count (yeasts and mould) were in the narrow range of 1.6-2.1 X 10^6 cfu/ml and 1.0-2.5 X 10^6 cfu/ml respectively in all the enriched Soy Spreads. Microbial study shows that the microbial counts (Total plate count, Fungal count) are within the accepted range and the products are free from *E.coli*, *Salmonella* and *Staphylococcus* infestation both at zero day and after seven days of storage at 10° C, there by supporting the fact that the different enriched Soy Spreads made are safe to consume.

Oxidative Shelf life

Table 4: Shelf life characteristics of Spreads based on Peroxide value and Free Fatty Acid determination (n=3)

Shelf Life Parameters	MS	RBS	SES	RBSES
Peroxide Value (0 Day)	3.0 ± 0.15^{a}	2.7 ± 0.13^{b}	2.5 ± 0.14^{c}	2.4 ± 0.23^{d}
Peroxide Value (7 Days)	4.5 ± 0.22^{a}	3.5 ± 0.20^{b}	2.9 ± 0.11^{d}	3.0 ± 0.20^{c}
Free Fatty Acid (0 Day)	1.7 ± 0.21^{a}	0.80 ± 0.105^{b}	0.44 ± 0.092^{c}	0.23 ± 0.094^{d}
Free Fatty Acid (7 Days)	2.3 ± 0.15^{a}	1.3 ± 0.10^{b}	0.63 ± 0.072^{c}	0.31 ± 0.040^{d}

Results have been expressed as mean ±SD (n=3).
Mean Values having different superscript letter in rows are significantly different (p<0.05). Values having same superscript letter in rows are not significantly different (p<0.05).
***MS** = Market Soy Spread (Control), **RBS** = RBO incorporated Soy Spread, **SES** = Sesame Oil incorporated Soy Spread, **RBSES** = RBO and Sesame oil incorporated Soy Spread*

Hydrolytic stability of the products enriched in bioactive spreads is much better than the market product as indicated by the free fatty acid content. Oxidative stability also indicates relatively more stable character against auto-oxidation of the enriched Soy Spreads compared to the market Soy Spread. The observations have been shown in **Table 4**.

Sensory Evaluation

Table 5: Sensory Quality of Market Soy Spread (control) and Bioactive Compounds Enriched Soy Spread products (n=3) [N=20 panelists] on the basis of 9 Point Hedonic Rating

Product	Colour	Odour	Taste	Texture	Overall Acceptability
MS	7.1 ± 0.07^{c}	7.7 ± 0.11^{a}	7.4 ± 0.16^{a}	8.1 ± 0.12^{a}	7.0 ± 0.14^{a}
RBS	7.8 ± 0.07^{b}	6.2 ± 0.07^{d}	6.4 ± 0.05^{d}	7.2 ± 0.08^{c}	6.2 ± 0.05^{d}
SES	7.8 ± 0.02^{b}	7.0 ± 0.11^{b}	6.7 ± 0.02^{c}	7.0 ± 0.11^{d}	6.4 ± 0.02^{c}
RBSES	8.0 ± 0.08^{a}	6.7 ± 0.08^{c}	6.8 ± 0.05^{b}	7.4 ± 0.05^{b}	6.7 ± 0.05^{b}

Results have been expressed as mean ±SD (n=3).
Mean Values having different superscript letter in rows are significantly different (p<0.05). Values having same superscript letter in rows are not significantly different (p<0.05).
***MS** = Market Soy Spread (Control), **RBS** = RBO incorporated Soy Spread, **SES** = Sesame Oil incorporated Soy Spread, **RBSES** = RBO and Sesame oil incorporated Soy Spread*

Organoleptic score of the various spreads have been evaluated in terms of colour, odour, taste, texture and overall acceptability by Hedonic rating scale and the results in **Table 5** shows good acceptance. Sensory evaluation points out also that Soy Spreads containing Sesame as well as RBO and Sesame Oil blend are having much better odour stability than only RBO incorporated Soy Spreads.

CONCLUSION

The present study leads to the conclusion that the process technology can be developed for producing some Soy Spreads comprising more desired fatty acid profiles such as MUFA and PUFA ratio and bioactive antioxidants like Oryzanol and Lignans which are expected to provide better shelf life of the products along with health beneficiary effects.

ABBREVIATIONS USED
RBO : Rice Bran Oil
MUFA : Mono Unsaturated Fatty Acid
PUFA : Poly Unsaturated Fatty Acid
MS : Market Soy Spread (Control)
RBS : RBO incorporated Soy Spread
SES : Sesame Oil incorporated Soy Spread
RBSES : RBO and Sesame oil incorporated Soy Spread

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