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Replacement of bakery shortening with rice bran oil in the preparation of muffins

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Studies were carried out to replace bakery shortening with refined rice bran oil in the preparation of muffins. Physico-chemical properties of bakery shortening and rice bran oil were studied. Rice bran oil was found to have a higher content of the essential fatty acid linoleic acid (34.98%) as compared to that of bakery shortening (5.14%). Chemical composition of wheat flour used was also studied. Muffin samples were prepared by replacing bakery shortening with rice bran oil at 0, 25, 50, 75 and 100% levels. Muffins were examined for quality that is weight, volume and specific volume and organoleptic quality that is appearance, colour, texture, flavour and overall acceptability on a 9 point hedonic scale. Statistical analysis revealed that muffin making and organoleptic quality of muffins prepared after replacing rice bran oil at the 50% level or greater varied significantly which is desirable from that of control. Statistically significant variations were observed in the texture of muffins prepared with shortening alone from that prepared after replacing bakery shortening with rice bran oil at 50% level.

Key words: Muffin, organoleptic quality, rice bran oil, shortening, texture.

INTRODUCTION

Rice is one of the most important crops in the world in addition to wheat and corn. Rice is cultivated in over 100 countries around the world and is a staple food for about half of the world population. The total paddy production area is about 154 million hectare and the annual production of rice is about 594 million tons. Brown rice grains contain more nutritional components, such as dietary fiber, E and B vitamins and gamma aminobutyric acid (GABA), than ordinary milled rice grains. These bio-functional components exist mainly in the germ and bran layers that are removed by polishing or milling (Champagne et al., 2004).

Rice bran oil (RBO) is generally considered to be one of the highest quality vegetable oil in terms of its cooking quality, shelf life and fatty acid composition (Sayre and Sunders, 1990). Rice bran oil is obtained from the outer brown layer of rice. Generally rice bran contains 15 to 20% oil (Marshall and Wadsworth, 1994). It is extensively used in Japan, Korea, China, Taiwan and Thailand as a "Premium Edible Oil". The oryzanol present in rice bran is reported to have functions similar to vitamin E in promoting growth, facilitating capillary growth in the skin, and improving blood circulation along with stimulating hormonal secretion (Luh et al., 1991). Rice bran oil is an excellent source of polyunsaturated fatty acids (PUFA) which are helpful in lowering cardiovascular risks. Rice bran oil lowered human blood Low-density lipoprotein (LDL) cholesterol more effectively than did sunflower while high-density lipoprotein (HDL) remain unchanged using corn and safflower oils (Suzuki and Oshima, 1962). Kirk and Sawyer (1999) investigated that refined oil in good

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condition has thiobarbi turic acid (TBA) values of 0.02-0.08 whereas crude oil or badly stored oils have 0.1-0.2. Furia (1968) reported a commercial test based on the reaction of 2- thiobarbituric acid with the oxidation products of fats and oils to form a red color. Joo et al. (2001) investigated effects of rice bran oil on the oxidative stability and nutritional properties of restructured beef roasts and concluded that addition of 2% rice bran oil (w/w) is effective in improving both oxidative stability and vitamin E levels of restructured beef roasts.

In the usual two-stage muffins method, the shortening and sugar are combined and mixed. During this step the air is dispersed into the solid phase. Then the eggs are incorporated, followed by the flour, liquids, and other ingredients. During the first creaming step, the plastic shortening entraps air bubbles. In the presence of an emulsifier such as 4% monoglyceride, these bubbles are divided into numerous small air cells by agitation. The shortening must be solid (so the bubbles do not escape), but also plastic so it can fold around each air pocket. This is best accomplished by a plastic shortening, crystallized in the beta prime (β^{I}) phase. If the shortening has trans-formed into the β phase, the large plates of solid fat are much less effective in entrapping the fat. A good short-ening for this type of cake batter production has the solid fat index profile of all-purpose shortening, containing added monoglyceride. The effects of both type and level of shortening on batter viscosity, specific gravity and shear force values of white cakes were studied by Matthews and Dawson (1983). As the level of shortening increased, specific gravity and shear force values decreased, while batter viscosity increased with increase in fat level upto 50%.

Muffins are less sweet than most cakes, and generally have a somewhat more open crumb structure (a close, fine grain is not desired). The shortening used is an all purpose (nonemulsified) type to avoid more raising in volume during baking. In some instances, a vegetable oil shortening is used, when an extremely open texture accompanied by a moist mouthfeel is desired. Shortening levels vary widely, from 18 to 35% based upon the amount of flour; tenderness of the finished product varies accordingly.

The baking industry is a developing market sector in India, which is growing in its volume. The people are becoming more conscious about health and nutrition. Foods that are convenient, with good taste, reasonably priced and carry a favorable nutritional image are in great demand. Among bakery products, especially muffins and cookies, fat and oil are one of the major ingredients. The functional and nutritional properties of RBO has appeared well suited to its usage as shortening in baked goods like muffins. Little research was found in the recent literature regarding the performance of vegetable oils in muffins.

MATERIALS AND METHODS

Raw materials

Flour, sugar, rice bran oil, salt and other ingredients for product preparation were procured from local market.

Chemical analysis of flour

Chemical characteristics of flour were analysed using standard procedures (AACC 2000).

Protein

Standard AACC (AACC, 2000) procedure given under 46-11 A was followed. Sample (weighed) was digested in Kjeldhal flask with digestion mixture (copper sulphate and potassium sulphate in 1:10 ratio) and concentrated H_2SO_4 (20 ml) till light green color and cooled. Ammonia released by distillation of digested sample with saturated NaOH (80 ml) was captured in 0.1 N HCl to calculate % nitrogen (N_2). The protein content was calculated as per cent N_2 x factor. The factor of 6.25 was used for calculation.

Ash

Standard AACC (AACC, 2000) procedure given under 08-01 was followed. Weighed sample (5 g) was charred on hot plate and incinerated in furnace at 550±10°C for 3 h. It was cooled, weighed and ash content was expressed as% ash.

Fat

Hydrogenated fat (Gagan brand, manufactured by Gagan Vanaspathi Ltd.) which had a melting point of 37°C was procured from the local market and used as shortening in the formulae for baking tests.

Refined rice bran oil

Refined Rice bran oil (Ricela) was procured from A.P. Solvex Ltd, Dhuri.

Leavening agent

Commercial baking powder (Weikfield Company) was used as leavening agent in muffin preparation.

Sugar

Powdered sugar was purchased from the local market for use in muffin preparation.

Salt

Salt used in muffin preparation was purchased from the local market.

Chemical analysis of rice bran oil and bakery shortening

Rice bran oil and bakery shortening were subjected to chemical analysis for the determination of colour, iodine value, saponification value, moisture, refractive index, peroxide value, free fatty acid value, specific gravity, smoke point and flash point according to methods given by AOAC (2000). Fatty acid profile of rice bran oil and bakery shortening was also studied according to methods given by AOAC (2000).

Table 1. Formula used for preparation of muffins.

Ingredient	Quantity (g)
Flour	100
Fat	57.13
Sugar	78.58
Salt	0.50
Baking Powder	2.9
Essence (Vanilla)	1.0
Eggs	100
Water	Required milliliter to get desired consistency of batter

Table 2. Different treatments used in the study.

Treatment	Normal shortening (%)	Rice bran oil (%)
T_1	100	-
T_2	75	25
T_3	50	50
T_4	25	75
T_5	-	100

T_1 = 100% normal shortening (NS); T_2 = 75% NS + 25% Rice Bran Oil (RBO); T_3 = 50% NS + 50% RBO; T_4 = 25% NS + 75% RBO; T_5 = 100% RBO.

Muffin making

Various ingredients and their quantity used in the preparation of muffins are given in Table 1. For the muffins method, standard AACC method (AACC, 2000) was used. For muffin making, shortening was used according to ratios as mentioned in Table 2.

Evaluation of muffin making quality

The muffins prepared were analyzed for weight, volume by seed displacement method measured and specific volume.

Sensory evaluation

The muffin samples were evaluated for appearance, colour, texture, flavour and overall acceptability by a panel of six trained judges on a nine point hedonic scale.

Texture studies

Firmness of muffin samples was analyzed by Stable Microsystem Texture Analyzer, the settings used for test were given: Test, Compression test; Probe, Flat disc; Pre-test speed, 1 mm/s; Test speed, 1 mm/s; Post-test speed, 1 mm/s; Distance, 15 mm; Force, 60 kg.

Statistical analysis

The data obtained for each parameter was subjected to statistical analysis to determine the level of significance according to the methods described by Steel et al. (1997).

RESULTS AND DISCUSSION

Chemical analysis of rice bran oil and bakery shortening

Data with regard to physico-chemical properties of bakery shortening and rice bran oil used in the study are presented in Table 3. Bakery shortening had colour 2R, 1.7Y, iodine value of 91.66, saponification value of 187.24, refractive index of 1.45, peroxide value of 0.92 meq/kg, free fatty acid value of 0.09%, moisture of 0.05%, specific gravity of 0.91, smoke point of 202.0°C and flash point of 271°C. Rice bran oil had colour 2.2R, 2Y, iodine value of 103.68, saponification value of 184.55, refractive index of 1.47, peroxide value of 0.88 meq/kg, free fatty acid value of 0.07%, moisture of 0.04%, specific gravity of 0.912, smoke point of 213° C and flash point of 280° C. Earlier Perzybylski and Mag (2002) studied the composition, properties and uses of vegetable oils used in food technology and reported similar results. Rice bran oil was found to be having a much higher content of linoleic acid (34.98) when compared to that of bakery shortening (5.14) as shown in Table 4.

Effect of different treatments on muffin making quality

Muffin volume and specific volume values were found to be more for muffins prepared after replacing bakery shortening with rice bran oil at 25, 50, 75 and 100% levels, in comparison to control (Table 5 and Figure 1). Maximum value for volume was observed in muffins prepared with 100% replacement of bakery shortening (170.00 cc) whereas minimum value for the same was observed in control (151.67 cc). Maximum value for specific volume was observed in muffins prepared with 100% replacement of bakery shortening (3.20 cc/g) whereas minimum value for the same was observed in control (2.78 cc/g). No significant differences were observed among control and different replacement levels in the values for weight. Earlier, Kamran et al. (2005) studied the development of improved quality of baked products by replacing bakery

Table 3. Physico-chemical properties of bakery shortening and rice bran oil.

Property	Bakery shortening	Rice bran oil
Colour (1.25" Lovibond red)	2R 1.7Y	2.2R 2Y
Iodine value	91.66	103.68
Saponification value	187.24	184.55
Refractive Index	1.45	1.47
Peroxide Value (meq/kg)	0.92	0.88
Free Fatty Acid (as% Oleic acid)	0.09	0.05
Moisture (%)	0.05	0.03
Specific gravity	0.91	0.91
Smoke point (°C)	202.00	213.00
Flash point (°C)	271.00	280.00

Each value is a mean of three observations.

Table 4. Fatty acid composition of bakery shortening and rice bran oil (g/100 g).

Sample	Palmitic acid	Stearic acid	Oleic acid	Linoleic acid	Linolenic acid	Arachidonic acid	Erucic acid
Bakery shortening	38.07	4.53	51.56	5.14	-	1.00	-
Rice bran oil	18.80	1.83	42.88	34.98	1.27	0.50	-

Each value is a mean of three observations.

Table 5. Effect of Different Levels of Rice Bran Oil on Muffin Making Quality.

Treatment	Weight (g)	Volume (cc)	Specific volume (cc/g)
T_1	54.50	151.67	2.78
T_2	54.00	155.00	2.87
T_3	55.17	166.67	3.03
T_4	54.17	163.33	3.02
T_5	53.17	170.00	3.20
CD (0.05)	NS	5.75	0.23

shortening with rice bran oil at 25, 50, 75 and 100% levels and reported similar results.

Effect of different treatments on the sensory quality of muffins

Muffins prepared after replacing bakery shortening with rice bran oil at 50% level were awarded higher scores for appearance in comparison to control. Maximum scores for texture were awarded to control muffins prepared with 100% bakery shortening (7.33) that is more tougher the muffins whereas minimum score was awarded to muffins prepared with 100% replacement of bakery shortening (6.17) that is more tender muffins. Overall acceptability of control muffins was best (7.96) in comparison to other levels of replacement (Table 6). Earlier, Kamran et al. (2005) studied the development of improved quality of baked products by replacing bakery shortening with rice bran oil at 25, 50, 75 and 100% levels and reported similar results.

Texture analysis of muffins

Control and muffins prepared after replacing bakery shortening with refined rice bran oils at 25, 50, 75 and 100% replacement levels were evaluated for firmness by texture analyser. Force required to compress (g) was measured. Significant variations were observed in firmness of muffins as shown in Table 7. Force required to compress the muffins was minimum (176.56 g) in case of muffins prepared by replacing bakery shortening with rice bran at 100% replacement level and maximum (186.26 g) in control muffins prepared with 100% bakery shortening.

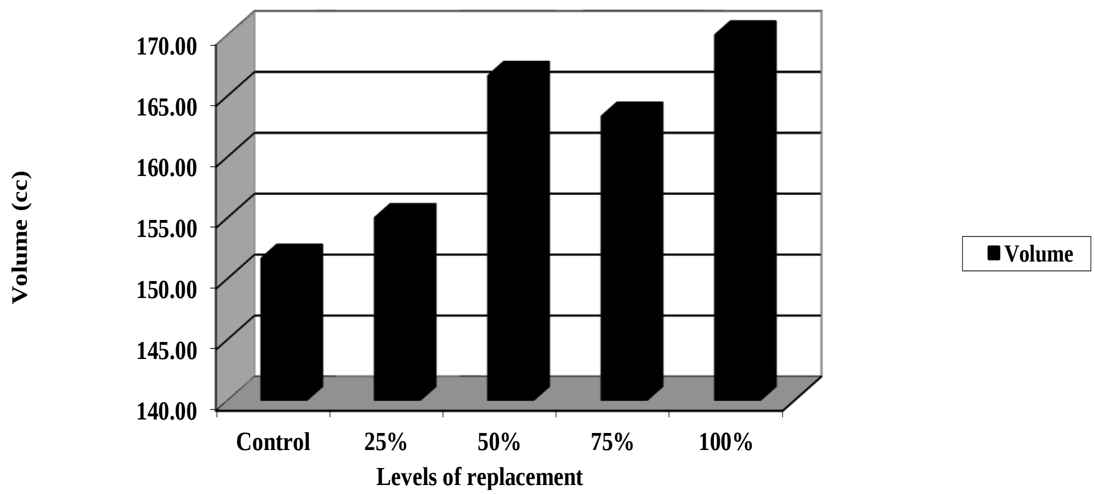

Figure 1. Effect of different levels of rice bran oil on the volume of muffins.

Table 6. Effect of different levels of rice bran oil on sensory quality of muffins.

Treatment	Appearance	Colour	Texture	Flavour	Overall acceptability
T_1	7.67	7.33	7.33	8.33	7.96
T_2	7.67	7.83	7.00	8.33	7.88
T_3	8.00	8.83	6.67	8.50	7.83
T_4	7.67	8.00	6.50	8.50	7.92
T_5	7.50	7.83	6.17	8.33	7.88
CD (0.05)	0.38	0.88	0.94	0.80	NS

Table 7. Effect of different levels of rice bran oil on the texture of muffins.

Treatment	Force (g)
T_1	186.26
T_2	185.76
T_3	183.51
T_4	181.33
T_5	178.46
CD (0.05)	0.001

Conclusion

It is concluded that bakery shortening can be successfully replaced with refined rice bran oil upto 50% level of replacement in the preparation of muffins with improvement in quality (functional and organoleptic) of the product. At 50% level of replacement, rice bran oil proved to be better than normal bakery shortening in the preparation of muffins as far as quality (functional and organoleptic) of the product was concerned. Hardness/crispness of the muffins decreased with increase in the level of replacement of bakery shortening with rice bran oil but the texture of muffins was found to be fairly acceptable upto 50% level of replacement of bakery shortening with rice bran oil.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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