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Value added egg muffins incorporating full fat rice bran (10 and 20%) and flax seeds (10%)

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Abstract
The present investigation was conducted to evaluate the nutrient composition of developed value added egg muffins incorporating full fat rice bran and flax seed. Value added Type I and Type II egg muffins contained full fat rice bran at the levels of 10 and 20 per cent, respectively but both contained 10 per cent flax seeds. The control had 10 per cent flax seeds but did not contain rice bran. The control egg muffins having flax seeds but no rice bran had 3 per cent moisture, 8.10 per cent crude protein, 21.20 per cent crude fat, 1.10 per cent crude fibre, 0.94 per cent ash and 68.60 per cent total carbohydrates. After addition of 10 and 20 per cent full fat rice bran in Type I and II egg muffins, the moisture, crude protein, crude fat, crude fiber, ash and total carbohydrate contents were changed to 3.40, 3.80; 8.30, 8.40; 24.90, 27.40; 2.20, 3.10;1.76, 2.52; and 62.73, 58.57 per cent, respectively. It was found that moisture, protein, crude fat, crude fiber and ash contents increased but total carbohydrates decreased significantly over the control upon supplementation of 20 per cent level of full fat rice bran and flax seeds in the egg muffins. Protein digestibility (*in vitro*) of control, value added Type I and Type II egg muffins were 78.76, 76.6 and 74.20 per cent, respectively and the difference were significantly ($P \leq 0.05$). Value addition also resulted in improvement in mineral profile of the products. Such developed products can be very useful in combating the micronutrients deficiency problem in population of all age groups.

Keywords: Rice bran, value addition, nutritional composition, fiber, protein digestibility (*in vitro*) and total minerals

Introduction
Rice bran, the brown outer layer of rice kernel is mainly composed of pericarp, aleurone/sub-aleurone layers and germ accounting for approximately 10% of the weight of the rice grain (Justo *et al.*, 2013) [1]. Currently, it is discarded as a waste product during the process of rice milling in India. However, it is an excellent source of total dietary fiber ranging from 20% - 51%. It is also a good source of proteins, lipids, vitamins and minerals. Chemically, it contains 11% - 17% protein, 11% - 18% fat, 10% fiber, 9% ash and 45% - 65% nitrogen free extract (NFE). It is a rich source of B-vitamins and minerals such as potassium, calcium, magnesium and iron. The amino acid profile of rice bran has been generally reported to be superior to cereal grain proteins. The low content of saturated fatty acids and high content of linoleic acid, poly-unsaturated fatty acids plus tocopherols makes rice bran a health beneficial food (Godber *et al.*, 2009) [2]. Defatted rice bran is also rich in proteins, minerals, and vitamins. Proteins are more concentrated in the rice bran and are unique in their nutritional value, which is quite comparable with that of its endosperm protein or protein from any other cereal or legume. The protein of rice bran is highly digestible and hypoallergenic food ingredient (Tan *et al.*, 2013) [3].

Soluble fibres present in the rice bran have gained popularity to reduce the postprandial glycemia in normal and diabetic subjects. Soluble fiber forms a gelatin- like substance in the intestine and increases the water content in the stool. It has also been demonstrated to possess the ability to decrease the blood cholesterol and sugar after meals in diabetics. Insoluble fiber plays a key role in adding bulk or softening stool, which helps to reduce constipation and haemorrhoids and is also effective in creating a feeling of fullness (Min *et al.*, 2011) [4].

The consumption of dietary fiber, especially the mixture of soluble and insoluble fiber, is inversely associated with the risk of cancer, such as colon cancer. Therefore, the presence of dietary fiber in high amount in rice bran might partly explain its effects on the reduction of cancer. The dietary fiber in rice bran that ferments slowly may exert its protective effects through the physical dilution of the contents of the gut through its potential for dilution and faecal bulking capacity (Kim *et al.*, 2012) [5].

As bakery products viz., breads and muffins are being widely consumed and therefore, can act as an ideal vehicle for nutraceutical delivery. Rice bran, soy flour, flax seeds, sesame seeds and inulin are some of the nutraceutical ingredients that may be incorporated into bread and

muffins to provide health benefits. New foods with new health claims such as multigrain bread/muffins, brown bread, garlic bread, rye bread, barley bread etc are flooding the market to meet the diverse demands of consumers. Value addition to existing foods with such ingredients is a simple and feasible way of enhancing nutritional values of foods and in turn the health benefits (Sharif *et al.*, 2009) [6]. Keeping it in view, the present study was conducted and findings reported in this paper.

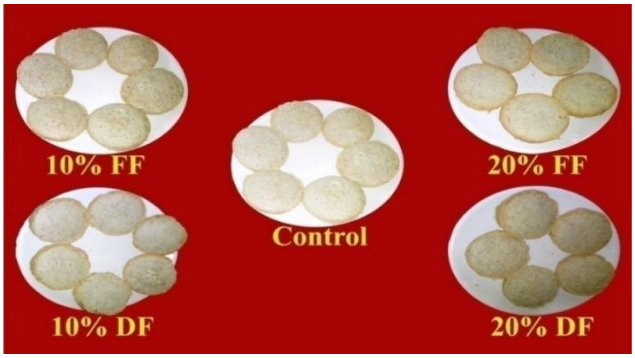
Materials and methods

Present study was carried out in Department of Foods and Nutrition, I.C. College of Home science, Chaudhary Charan Singh Haryana Agricultural University, Hisar. Rice bran was procured in a single lot from the rice mill located at Yamunanagar. For the preparation of egg muffins the required ingredients namely, eggs, refined flour, butter, flax seeds, ammonia and baking powder were purchased in a single lot from the local market of Hisar.

Nutritional evaluation of value added eggless muffins incorporating full fat rice bran

Moisture, ash, crude fat, crude protein and crude fiber were estimated by employing the standard methods of analysis AOAC, 2012 [7]. The total carbohydrate was calculated by the difference method. Total carbohydrate (%) = 100 – [crude protein (%) + crude fat (%) + crude fiber (%) + total ash (%)]. Total, soluble and insoluble dietary fiber constituents were determined by the enzymatic method given by Furda, 1981 [8]. Total calcium, iron, zinc, potassium and magnesium in acid digested samples were determined by Atomic Absorption Spectrophotometer according to the method of Lindsey and Norwell 1969 [9]. Phosphorus was determined colorimetrically by the method of Chen *et al*., 1956 [10]. Ionizable iron in the samples was extracted according to the procedure of (Rao and Prabhavati 1978) [11]. *In vitro* protein digestibility was carried out by using the modified method of (Mertz *et al.* 1983) [12].

Results and Discussion



Value added egg muffins

Value added Type I and II egg muffins had 10 and 20 per cent of full fat rice bran, respectively while both of them had 10 per cent flax seeds. Control egg muffins had 10 per cent flax seeds but did not contain rice bran. These muffins were liked the most by the judges.

The data presented in Table 1 depicts that the control egg muffins having flax seeds but no rice bran had 3 per cent moisture, 8.10 per cent crude protein, 21.20 per cent crude fat, 1.10 per cent crude fibre, 0.94 per cent ash and 68.60 per cent total carbohydrates. After addition of 10 and 20 per cent full fat rice bran in Type I and II egg muffins, the moisture, crude protein, crude fat, crude fiber, ash and total carbohydrate contents were changed to 3.40, 3.80; 8.30, 8.40; 24.90, 27.40; 2.20, 3.10;1.76, 2.52; and 62.73, 58.57 per cent, respectively. It was found that moisture, protein, crude fat, crude fiber and ash contents increased but total carbohydrates decreased significantly over the control upon supplementation of 20 per cent level of full fat rice bran in the egg muffins. The addition of full rice bran and flaxseeds improved the proximate composition, dietary fiber contents of breads (Ajmal *et al.* 2006) [13]. Similar findings were supported by (Ameh *et al.* 2013) [14]. Moisture, crude protein, crude fat, crude fiber and ash in breads prepared from the composite flour of refined flour and rice bran were 21.07 to 23.67 per cent, 12.04-13.14 per cent, 1.57-3.77 per cent, 1.76-2.91 per cent and 1.46-2.41 per cent, respectively.

Table 1: Proximate composition of value added egg muffins incorporating full fat rice bran (10 and 20%) and flax seeds (@ 10%) (%, dry weight basis)

Levels of full fat rice bran in egg muffins containing soy flour	Moisture	Crude protein	Crude fat	Crude fiber	Ash	Total carbohydrates
Control (90:10::RF:RB:FS)	3.00±0.06	8.10±0.10	21.20±0.06	1.10±0.06	0.94±0.01	68.60±0.12
Type I (80:10:10:: RF:RB:FS)	3.40±0.06	8.30±0.12	24.90±0.12	2.20±0.06	1.76±0.01	62.73±0.09
Type II (70:20:10:: RF:RB:FS)	3.80±0.06	8.40±0.10	27.40±0.10	3.10±0.06	2.52±0.02	58.57±0.09
CD ($P \leq 0.05$)	0.19	0.36	0.32	0.19	0.03	0.35

Values are mean ± SE of three independent determinations
RF: Refined flour RB: Rice bran FS: Flax seeds

Total dietary fiber contents of control, Type I and Type II egg muffins were observed as 2.18, 4.34 and 6.51 g/100g, respectively and the differences were significant ($P \leq 0.05$). Highest amount of total dietary fiber content was present in Type II egg muffins incorporating 20 per cent full fat rice bran and flax seeds and the lowest in control. Type II egg muffins incorporating 20 per cent full fat rice bran had maximum amount of (1.11 g/100g) soluble dietary fiber too over the control egg muffins (0.49 g/100g) and the differences were significant. Insoluble dietary fiber contents of control, value added Type I and Type II egg muffins incorporating full fat rice bran were found to be 1.69, 3.26 and 5.40 g/100g,

respectively which were significantly different. (Krishnan *et al*., 1998) [15] studied the effects of oat bran supplementation (10-15%) in muffins. Dietary fiber and protein contents increased significantly with oat bran supplementation up to 10 per cent. Dietary fiber contents of muffins improved due to the supplementation with flaxseed and rice bran in wheat flour. The flaxseed was rich in insoluble, soluble and total dietary fibre, and the addition of flaxseeds resulted in the improvement of dietary fiber contents of products in which it was present. Similar findings were supported by Ameh *et al.* (2013) [16].

Table 2: Dietary fiber content of value added egg muffins incorporating full fat rice bran (10 and 20%) and flax seeds (@ 10%) (g/100g, on dry weight basis)

Levels of full fat rice bran in egg muffins containing soy flour	Total dietary fiber	Insoluble dietary fiber	Soluble dietary fiber
Control (90:10:: RF:RB:FS)	2.18±0.08	1.69±0.06	0.49±0.07
Type I (80:10:10::RF:RB:FS)	4.34±0.05	3.26±0.07	1.07±0.08
Type II 70:20:10::RF:RB:FS)	6.51±0.09	5.40±0.08	1.11±0.05
CD (P≤0.05)	0.11	0.09	0.08

Values are mean ± SE of three independent determinations
RF: Refined flour RB: Rice bran FS: Flax seeds

Table 3 indicated that protein digestibility (*in vitro*) of control, value added Type I and Type II egg muffins were 78.76, 76.6 and 74.20 per cent, respectively and the difference were significantly (P≤0.05).

Table 3: Protein digestibility (*in-vitro*) of value added egg muffins incorporating full fat rice bran (10 and 20%) and flax seeds (@ 10%) (%, on dry weight basis)

Levels of full fat rice bran in egg muffins containing flax seeds	Protein digestibility (*in vitro*)
Control (90:10:: RF: FS)	78.76±0.07
Type I (80:10:10 ::RF:RB:FS)	76.60±0.05
Type II (70:20:10:: RF:RB:FS)	74.20±0.04
CD (P≤0.05)	0.06

Values are mean ± SE of three independent determinations
RF: Refined flour RB: Rice bran FS: Flax seeds

Total calcium contents of control, value added Type I and Type II egg muffins were observed as 29.0, 35.9, 42.9 mg/100g, respectively and the differences were significant (P≤0.05). Among all the egg muffins, Type II egg muffins incorporating 20 per cent full fat rice bran had significantly (P≤0.05) higher total calcium contents when compared to that of Type I and control egg muffins (Table 4).

Value added Type II egg muffins incorporating 20 per cent full fat rice bran and flax seeds had 9.58 mg of total iron per 100g, which was significantly (P≤0.05) higher than that of Type I egg muffins incorporating 10 per cent full fat rice bran (6.38 mg/100g) and control (3.18mg/100) egg muffins. Total phosphorus content was significantly (P≤0.05) higher in value added Type II egg muffins incorporating 20 per cent full fat rice bran (344.30 mg/100g) followed by Type I (210.90 mg/100g) and control (77.73 mg/100g) egg muffins Minimum amount of total phosphorus was observed in control egg muffins containing flax seeds (Table 4).

A significant difference was observed in total magnesium contents of control, Type I and Type II egg muffins. Type I (147.9mg/100g) and Type II (237.90mg/100g) egg muffins containing full fat rice bran had significantly (P≤0.05) higher total magnesium content over the control (57.90mg/100g). The value of total magnesium contents in value added Type II egg muffins having full fat rice bran and flaxseeds was found to be many fold higher when compared to that of value added Type I and control egg muffins.

Similarly, total potassium contents was also the highest in value added Type II egg muffins (359.80 mg/100g) when compared to that of value added Type I (216.30mg/100g) and control (72.80mg/100g) egg muffins and the differences were significant (P≤0.05). These finding corroborate with those of (Sairam *et al.* 2011) [17] who observed increase in dietary fiber and minerals with increasing level of rice bran.

Table 4: Total mineral content of value added egg muffins incorporating full fat rice bran (10 and 20%) and flax seeds (@ 10%) (mg/100g, on dry weight basis)

Levels of full fat rice bran in egg muffins containing flax seeds	Calcium	Phosphorus	Iron	Potassium	Magnesium
Control (90:10::RF:FS)	29.00±0.58	77.73± 0.09	3.18±0.06	72.80±0.12	57.90±0.08
Type I (80:10:10::RF:RB:FS)	35.90±0.15	210.90±0.15	6.38±0.09	216.30±0.16	147.90±0.09
Type II (70:20:10::RF:RB:FS)	42.90±0.06	344.30±0.22	9.58±0.16	359.80±0.24	237.90±0.11
CD (P≤0.05)	1.15	0.24	0.17	0.23	0.14

Values are mean ± SE of three independent determinations
RF: Refined flour RB: Rice bran FS: Flax seeds

Data regarding available calcium and iron contents of control and value added egg muffins have been presented in the Table 5.

There were significant differences in available calcium contents of control and value added Type I and Type II egg muffins. Type II egg muffins had significantly (P≤0.05) higher available calcium (16.65mg/100g) followed by that of Type I (14.68mg/100g) and control (13.90 mg/100 g) egg muffins. Although the total and available calcium contents were significantly (P≤0.05) higher in value added Type II and Type I egg muffins, but the calcium availability was less from them; per cent availability was the highest from control (47.93%) and the lowest from value added Type II (38.75%) egg muffins.

Similar was the situation in case of iron availability. Per cent availability of iron was observed to be the highest from control egg muffins (42.58%) and the lowest from Type II egg muffins (24.60%).

Table 5: Availability of calcium and iron contents of value added egg muffins incorporating full fat rice bran (10 and 20%) and flax seeds (@ 10%) (mg/100g, on dry weight basis)

Levels of full fat rice bran in egg muffins containing flax seeds	Total calcium	Available calcium	Total iron	Available iron
Control (90:10 RF:FS)	29.00±0.58	13.90±0.06 (47.93%)	3.18±0.024	1.35±0.02 (42.58%)
Type I (80:10:10::RF:RB:FS)	35.90±0.55	14.68±0.01 (40.82%)	6.38±0.06	1.87±0.03 (28.76%)
Type II (70:20:10::RF:RB:FS)	42.90±0.61	16.65±0.03 (38.75%)	9.58±0.09	2.35±0.04 (24.60%)
CD ($P \leq 0.05$)	1.15	0.12	0.07	0.06

Values are mean ± SE of three independent determinations
RF: Refined flour RB: Rice bran FS: Flax seeds
Values in parenthesis indicate per cent availability of the mineral.

Conclusion

Incorporation of full fat rice bran and flax seeds significantly ($P \leq 0.05$) improved the nutrient and mineral profile of egg muffins. Such developed products can be very useful in combating the micronutrients deficiency problem in population of all age groups.

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