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Development of Low Fat Fibre Rich Meatballs Using Hydrated Wheat Bran

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ABSTRACT

The current study was aimed at optimizing the amount of fat and dietary fibre content for the production of low fat fibre rich meatballs (locally called as *Rista*). In the first experiment, different combinations of lean meat, animal fat, and vegetable fat (T1 = 90% lean meat: 10% animal fat; T2 = 90% lean meat: 5% animal fat: 5% vegetable fat; T3 = 90% lean meat: 10% vegetable fat) were compared to control (T0 = 80% lean meat: 20% animal fat). Based on physicochemical, proximate, dietary fibre content and sensory scores, T1 (90% lean meat: 10% animal fat) was found optimum for the formulation of functional meatballs. In the second experiment, hydrated wheat bran as dietary fibre source was incorporated at three levels (4, 8, and 12%) replacing lean meat in the formulation of gravy-based products. 8% HWB was found optimum for the development of functional meatballs. It was concluded that the formulation containing 82% lean meat, 10% animal fat, and 8% hydrated wheat bran was suitable for the preparation of functional meatballs.
Keywords: Dietary fibre, texture profile, *Rista*, water activity, meatballs, functional.

Introduction

Meat ranks among one of the most significant, nutritious and energy rich natural food products, consumed by the humans to fulfill their regular body requirements. It is an essential component of the human diet to ensure optimal growth and development. Meat is valued as a complete protein food containing all the amino acids necessary for the human body. It is also a rich source of variety of fatty acids, minerals and vitamins (Ahmad et al. 2018). According to 20th Livestock Census, the total livestock population in India was 535.78 million, of which sheep contributed 74.26 million (13.87%) of the total livestock population. The total meat production in India was found to be 9.29 MT, of which sheep meat share is 10.33 percent (DAHD 2023).

India is very famous for its traditional meat products. A variety of traditional/ethnic meat products of indigenous taste profiles are prepared and consumed in India. Traditional meat products are high sensory quality foods, usually with high nutritional value, produced in a small scale, using ingredients and the procedures from ancient times. *Wazwan,* a famous cuisine of Kashmir valley is considered as an art and a point of pride in Kashmiri culture and identity. *Rista* is an emulsion based communited meat product, usually prepared from lean meat in which considerable amount of fat (20%) is used to achieve a stable emulsion and to impart a special taste and flavour to the product which has raised concerns among health-conscious consumers that impelled the need to adopt fat reduction strategy. The overall product functionality can be improved using fat replacers, salt replacers, dietary fibre sources and also by modification of fat profile by increasing healthy fats (omega-3 fatty acids) and other health improving components in the formulation (Zhang et al. 2010). Since the meat is deficient in dietary fibre, there is an urgent need to enrich these products with healthy source of dietary fibre. Wheat (*Triticum aestivum*) is a leading cereal crop which is mainly utilized for human consumption and livestock feed. It contains 33.4-63% dietary fibre, 8.1-12.7% moisture, 3.9-8.10% ash, 9.60-18.6% protein and 60-75% total carbohydrate (Curti et al. 2013). Since wheat bran is a rich source of dietary fibre and bioactive compounds such as phenolic acids, arabinoxylans, alkyl resorcinol and phytosterols, which can improve bowel health and prevent deadly diseases like colon cancer, reduce plasma cholesterol and blood glucose (Patel 2015), the incorporation in *Rista* could prove favourable in enhancing its functional value. Thus, current study was considered to optimize the fat content and hydrated wheat bran level in the formulation of functional meat balls (*Rista*).

Materials And Methods

Lean meat obtained from hind leg portions of the freshly dressed sheep carcasses (12-18 months old male animal) was used along with animal fat and other ingredients for the preparation of meatballs. Table salt, vegetable oil, and wheat bran used in product preparation were procured from the local market as per requirement. Wheat bran was hydrated with chilled water (1:1 hydration) and was kept as such for 30 minutes at refrigeration temperature before use.

Mutton chunks and mutton fat were minced separately through 8 mm plate in a meat mincer. The required quantity of minced meat was placed in the bowl chopper and chopping was done for 1 minute. To this, 2.5% table salt was added and chopping was continued for further 1 minute after which minced mutton fat was added and chopping was continued for 2 minutes. At this stage, 10% chilled water was added and again chopping was done for 2 minutes. Large cardamom seeds and hydrated wheat bran was added towards the end and chopping was continued for further 1-2 minutes to obtain an emulsion of desirable quality. The emulsion was moulded in the shape of spherical balls and were kept under refrigeration for half an hour and cooked in their respective gravies. The core temperature of meatballs was recorded by using a probe thermometer, which showed a core temperature of 72^0C at the end of the cooking process. The cooked product along with the gravy was cooled to room temperature and analysed for different parameters.

Analytical procedures

The pH of the cooked samples was determined as per the method of (Trout et al. 1992) by using a digital pH meter (Model CP 901, Century Instruments Ltd., and India). The emulsion stability of the raw emulsion was determined as per the method of (Baliga and Madaiah, 1970) by taking 25g of raw emulsion from each treatment in duplicate and placed in LDPE bags. The bags were sealed and weighed. The cooked samples (80^0C for 20 minutes) were allowed to cool down. The samples were weighed and loss in weight was expressed in percentage as an index of emulsion stability. The cooking yield was calculated and expressed in percentage by recording individual weights of *Rista* balls before and after cooking. The percentage moisture, protein, fat and ash content of the product samples were evaluated as per the standard procedure of AOAC (2019) using a hot air oven, kjeldahl assembly, soxhlet extraction apparatus and muffle furnace, respectively.

Colour was determined as per the method of (Hunter and Harold, 1987) by using a Hunter Lab Colorimeter (Model SN 3001476, Accuracy Micro Sensors, New York). Readings were displayed as L*, a*, b* colour parameters according to the CIELAB system of colour measurement. The estimation of texture profile was evaluated by following the procedures as described by (Bourne, 1978). The parameters were measured using a TA-XT2 Texture Analyzer (Perkin Elmer Private Limited, Godalming, Surrey UK) with a 35 mm diameter cylindrical flat probe. A 5 kg load cell was used to carry out the test. The testing conditions were kept as – pre-test speed-1mms⁻1; post-test speed – 10 $mms^{-1,}$ test speed – 3mms^{-1} , trigger force – 50N and travel distance of the probe was kept as 5mm.

Dietary fibre was determined by the method described by (Lee et al. 1992). Meat sample of (1g) in duplicate were taken in 400 ml tall form beakers. 40 ml MES-TRIS blend buffer solution (pH 8.2) was added to each beaker and stirred on magnetic stirrer until sample was completely dispersed in solution. 50μL heat-stable α-amylase solution was added while stirring at low speed. Aluminium foil covered samples were kept in shaking water bath at 98-100°C and incubated for 30 min with continuous agitation. All sample beakers were removed from hot water bath and cooled to 60°C. 100μL protease solution was added to each sample and incubated in shaking water bath at 60±1°C with continuous agitation for 30 min. pH of the samples was adjusted to 4.1-4.8 using HCl/NaOH solutions. To it 200μL amyloglucosidase solution was added while stirring on magnetic stirrer and then incubated in shaking water bath at 60°C for 30 min with constant agitation. To it 4 volumes of 95% ethanol were added followed by filtration and collection of both residue and precipitate and again washed by 15 ml 78% ethanol, 95% ethanol and acetone in that order which was followed by drying and weighing. Weight of CP and ash was subtracted from it giving TDF.

The sensory evaluation of the products and their gravies were conducted according to the method of (Keeton et al. 1983) wherein the product chunks in their respective gravies were served hot to the panellists comprising of scientists and postgraduate students of the Division of Livestock Products Technology, Shuhama. The product samples and their gravies were evaluated for various sensory parameters viz. appearance, flavour, texture, juiciness, consistency, binding, saltiness, mouth coating, and overall acceptability using an 8-point descriptive scale, where 8 is extremely desirable and

1 is extremely undesirable. Plain water was provided to the panellists to rinse the mouth at intervals between the samples. The data generated was analysed statistically using the software of Statistical Package for Social Sciences (SPSS-Base 20.0). Analysis of variance by one-way and independent t-Test was computed and the significance of mean was tested at a 5% level of significance.

Results And Discussion

Optimization of fat content in *Rista* (meatballs cooked in gravy)

The emulsion stability and cooking yield was decreased from T_0 to T_3 with T_1 showing comparable results with T_0. However, among the treatments, T_1 had numerically highest value for emulsion stability which might be due to holding and entrapping of moisture (because of more protein content than that of other treatments) during application of heat (80°C). The cooking yield was decreased from T_0 to T_3 with T_1 showing numerically higher value than T_0 which might be due to better binding of T_1 in comparison T_0, T_2 and T_3. The result is in agreement with (Choi et al. 2009), who reported decrease in emulsion stability of low fat meat emulsion with pork fat replaced with olive oil, grape seed oil, corn oil, canola oil and soyabean oil. The results are also in agreement with (Liu et al. 1991) who observed decrease in cooking yield in ground beef patties with replacement of beef fat with corn oil. The pH value of *Rista* decreased non-significantly ($p>0.05$) from T_0 to T_3. However, among the treatments, T_1 was having the highest pH and T_3 lowest. Present findings are in agreement with (Turp and Serdaroglu, 2007) who observed decrease in pH content in sucuk samples when beef fat was replaced with hazel nut oil. However, our result was in contrary with (Choi et al. 2009) who found increase in pH of low fat meat emulsion with pork fat replaced with vegetable fat and rice bran.

A significant ($p<0.05$) increase in the moisture content was found among the treatments which could be attributed to decreasing solids. The results are in agreement with (Paneras and Bloukas, 1994) who observed increase in moisture content in low fat frankfurters with incorporation of olive oil. The protein content of *Rista* was decreased from T_0 to T_3. However, among the treatments, T_1 had the highest protein content, which might be attributed to more lean meat present in it (90%). However, T_2 and T_3 also had same percentage of lean meat, but there was decrease in protein content, which might be attributed to poor binding which led to ingression of some proteins towards gravy. Present findings are in agreement with (Turp and Serdaroglu, 2007) who observed decrease in protein content in sucuk with 15% of beef fat replaced with hazel nut oil

The fat content of *Rista* was decreased significantly ($p<0.05$) from T_0 to T_3. T_0 had the highest fat content among all the treatments which might be attributed to more animal fat used in it. However, in T_2 and T_3, there was decrease in fat content which might be due to poor binding of the product by the addition of vegetable oil. The result is in agreement with (Liu et al. 1991) who observed decrease in fat content in ground beef patties with replacement of beef fat with corn oil.

The ash content of *Rista* decreased from T_0 to T_3. However, among the treatments, T_1 had numerically highest ash content which might be attributed to more lean meat in T_1 and hence more ash content. However, T_2 and T_3 also had same percentage of lean meat, but there was decrease in ash content which might be due to poor binding of the product with the addition of vegetable oil and hence leakage of some ash towards the gravy. The result are in agreement with (Paneras and Bloukas, 1994) who observed decrease in ash content in low fat frankfurters with incorporation of sun flower oil.

The sensory attributes of T_1 were comparable with T_0. T_2 and T_3 showed significantly ($p<0.05$) lower scores as compared to T_0 and T_1 (Choi et al. 2009) reported that the sensory attributes were comparable between the control sample and the treatment when pork back fat was replaced with vegetable oil and rice bran.

Table 1. Effect of fat optimization on the physicochemical quality and compositional quality of *Rista* (Mean ± S.E.)

Parameters (on % basis except pH)	Treatments			
	T_0	T_1	T_2	T_3
Emulsion stability	87.59 ± 0.59^{c}	87.85 ± 0.45^{c}	85.48 ± 0.58^{b}	82.23 ± 0.003^{a}
Cooking yield	88.76 ± 0.75^{c}	88.86 ± 0.67^{c}	86.58 ± 0.48^{b}	84.24 ± 0.008^{a}
pH	6.24±0.02	6.29±0.02	6.28±0.02	6.27±0.02
Moisture	63.24 ± 0.006^{a}	71.46 ± 0.011^{b}	73.45 ± 0.003^{c}	76.23 ± 0.11^{d}
Protein	15.32 ± 0.005^{c}	16.22 ± 0.005^{d}	15.01 ± 0.003^{bc}	14.82 ± 0.003^{a}
Fat	17.21 ± 0.003^{d}	8.95 ± 0.004^{c}	7.45 ± 0.003^{b}	5.21 ± 0.003^{a}
Ash	2.40 ± 0.21^{a}	2.47 ± 0.02^{b}	2.45 ± 0.02^{ab}	2.43 ± 0.03^{ab}

Mean ± S.E with different superscripts differ significantly ($P<0.05$).

N = 6 except for cooking yield and emulsion stability in which N = 3

Table 2. Effect of fat optimization on the sensory quality of *Rista* (Mean ± **S.E.**)

Parameters	Treatments			
	T_0	T_1	T_2	T_3
Appearance	7.67±0.16^{c}	7.47±0.19^{c}	6.87±0.22^{b}	6.07±0.18^{a}
Flavour	7.73±0.15^{c}	7.47±0.19^{c}	6.67±0.19^{b}	6.00±0.14^{a}
Juiciness	7.67±0.16^{b}	7.33±0.21^{b}	6.53±0.17^{a}	6.13±0.19^{a}
Texture	7.67±0.16^{c}	7.47±0.19^{c}	6.73±0.21^{b}	5.93±0.21^{a}
Mouth coating	7.07±0.12	7.13±0.13	6.87±0.19	6.73±0.23
Binding	7.00±0.14^{b}	7.07±0.12^{b}	6.27±0.25^{a}	5.80±0.24^{a}
Saltiness	7.13±0.09^{a}	7.20±0.22^{a}	7.07±0.18^{a}	7.00±0.17^{a}
Overall acceptability	7.73±0.15^{c}	7.47±0.22^{c}	6.80±0.20^{b}	5.93±0.12^{a}

Mean ± S.E with different superscripts differ significantly(P<0.05).
N = 15

Optimisation of hydrated wheat bran in the formulation of *Rista* (meatballs cooked in gravy) The emulsion stability of HWB incorporated *Rista* was significantly (p<0.05) higher than control and increased significantly (p≤0.05) with increase in the levels of HWB. The increase in emulsion stability with the addition of HWB might be attributed to increased holding and entrapping of moisture by wheat bran during application of heat at 80ºC. The results are in agreement with those of (Rendhe et al. 2018) who reported that with the addition of increasing amount of HWB in spent hen nuggets, an increase in emulsion stability was observed. Similar results were also found by (Huffman, 1992) in lean pork sausages by addition of fibre and (Huges et al. 1997) in frankfurters with addition of oat fibre.

Addition of HWB to *Rista* led to an increase in cooking yield with increase in the level of HWB which might be attributed to the ability of wheat bran to hold the moisture and fat in the matrix (Rendhe et al. 2018). The results are in agreement with (Cofrades et al. 2000) who stated that the increase in cooking yield with the addition of dietary fibre might be due to their water and fat binding properties. (Gupta et al. 2013) also reported that incorporation of apple pomace and carrageen in chicken patties increased the cooking yield significantly (p≤0.05) at all levels as compared to control.

The pH value of *Rista* treated with HWB increased slightly with increase in concentration of HWB which can be attributed to higher innate pH of wheat bran (8.5) as compared to lean meat (5.86). The results are in agreement with Yilmaz (2005), who reported that incorporation of wheat bran in low fat meat balls resulted in significant (p≤0.05) increase in pH of meat balls. Similar results were reported by (Talukdar and Sharma, 2010) in chicken meat patties incorporated with wheat bran and oat bran.

The moisture content of *Rista* increased with increasing levels of HWB. This increase might be due to the ability of fibre to retain more moisture in the meat emulsion. The results are in agreement with the results of (Ahmad, 2014), who observed increase in moisture content of functional restructured buffalo meat incorporated with increasing levels of wheat bran.

The protein content of *Rista* decreased with increase in levels of HWB. The decrease might be attributed to low protein content of wheat bran (11-13%) as compared to meat (20-26%). The replacement of high protein meat with low protein wheat bran might have resulted in decrease in the protein content (Rendhe et al. 2018). The results are in agreement with (Talukdar and Sharma, 2010) who reported that the addition of wheat bran and oat bran decreased the protein content in chicken meat patties. The result was also supported by (Yadav et al. 2017), who observed a decrease in protein content in chicken sausage by incorporation of wheat bran and dried carrot pomace.

The fat content of *Rista* decreased with increase in level of HWB. The decrease might be due to low fat content of wheat bran (2-3%) as compared to lean meat which contains about 5-6% fat. The findings are in agreement with (Mansour and Khalil, 1999), who observed decreased fat content in beef burgers by incorporation of wheat fibre. (Soltanizadeh and GhiasiEsfahani, 2015), also reported a decreased fat content for Aloe Vera incorporated low meat burgers. The results are also in agreement with the findings of (Miguel et al. 1999) who observed a decrease in fat content of frankfurters with addition of peach dietary fibre.

The ash content of *Rista* was increased with increase in levels of HWB, which might be attributed to more mineral content in wheat bran in comparison to meat. The results corroborate with the findings of (Yilmaz, 2004) who observed an increase in ash content of low fat meat balls upon incorporation with wheat bran. (Verma et al. 2016) also observed an increase in ash content of functional pork loaves incorporated with inulin powder as fibre.

The dietary fibre content of *Rista* increased significantly (p≤ 0.05) as the levels of HWB, since wheat bran is a super rich source of fibre (50-63%), the increase in dietary fibre content in *Rista* was evident. The results are in agreement with those of (Yadav *et al*. 2017), who also found an increasing trend in fibre content of chicken sausages with increasing levels of wheat bran. (Ahmad, 2014) has also observed significant ($p \leq 0.05$) increase in dietary fibre in wheat bran incorporated buffalo meat fillets.

The results revealed that the hardness values of *Rista* increased significantly ($p<0.05$) with increase in the levels of HWB. This increase might be due to the incorporation of fibre in a communited meat emulsion, which resulted in a high order of network organization leading to a harder texture (Grossi et al. 2011). The findings are in conformity with those of (Saricoban et al. 2009) who observed an increase in hardness values of beef patties with addition of wheat bran. Similar results were also found by Yilmaz (2005) in meat balls incorporated with wheat bran.

Cohesiveness values of *Rista* decreased non-significantly ($p>0.05$) with increase in the level of HWB. The results are in agreement with that of (Rendhe et al. 2018), who observed a decrease in cohesiveness values in spent hen nuggets by incorporation of hydrated wheat bran. Similar results were also found by (Yadav et al. 2017) in chicken sausages with the addition of wheat bran.

The springiness values of *Rista* decreased significantly ($p<0.05$) with increase in level of HWB. The decreased springiness values of *Rista* with increase in levels of HWB might be due to the formation of gel with the incorporation of hydrated wheat bran on cooking, which led to decrease in elasticity properties. The results are in agreement with the (Saricoban et al. 2009), who reported decreased springiness values for beef patties incorporated with wheat bran.

Chewiness and gumminess values are directed by hardness and cohesiveness values. There was a significant ($p<0.05$) increase in gumminess and chewiness values of *Rista* with increase in level of HWB which might be due to the higher hardness values. Present findings are in agreement with (Haung et al. 2005), who reported an increase in chewiness and gumminess values in Kungwan (ground and emulsified pork meat balls) with the incorporation of rice bran. Similar results were also reported by (Rendhe et al. 2018) for spent hen nuggets incorporated with hydrated wheat bran.

Resilience values of *Rista* decreased non-significantly ($p>0.05$) with increase in level of HWB. The trend can be attributed to increase in hardness along with decrease in springiness values with the incorporation of wheat bran. Present findings are in agreement with (Saricoban et al. 2009), who observed significant decrease in resilience values with the addition of wheat bran in beef patties. Similar results were also found by (Rendhe et al. 2018) for spent hen nuggets incorporated with hydrated wheat bran.

Lightness values of HWB incorporated *Rista* increased significantly ($p<0.05$) with the increase in level of HWB, which indicated that the HWB resulted in lighter coloured products. Decrease in appearance and colour of hydrated wheat bran added *Rista* was in consonance with increased in lightness. Present findings are in agreement with the (Yilmaz, 2004), who observed an increase in lightness values of low fat meat balls incorporated with wheat bran. Similar results were also found by (Yasarlar et. al. 2007) for Turkish meat balls incorporated with cereal bran.

Redness values of HWB incorporated *Rista* decreased significantly ($p<0.05$) with increase in level of HWB. The decrease in redness values of HWB incorporated *Rista* might be attributed to dilution of redness of lean meat with addition of white coloured wheat bran. Present findings are in agreement with (Rendhe et al. 2018) who observed decrease in redness values of spent hen nuggets incorporated with hydrated wheat bran. Similar results were also found by (Lin and Haung, 2003) for low fat frankfurters added with konjac/gellan gum mixed gels.

Yellowness values of HWB incorporated *Rista* increased significantly ($p<0.05$) with increase in level of HWB. The increased yellowness values of HWB incorporated *Rista* might be due to the presence of carotenoid pigments of wheat bran (Yilmaz, 2005). Present results are in agreement with (Rendhe et al. 2018) who observed increase in yellowness values of spent hen nuggets incorporated with hydrated wheat bran. Similar results were also found by (Hughes et al. 1997), who also observed increase in yellowness values in frankfurters with the addition of oat bran

Most of the sensory attributes including appearance, flavour, juiciness, mouth coating, saltiness and overall acceptability showed a declining trend with increase in level of HWB. However, the sensory attributes like texture and binding of HWB incorporated *Rista* increased significantly ($p<0.05$) with increase in levels of HWB. These results were in agreement with (Talukdar and Sharma, 2010) for chicken meat patties and (Yasarlar et al. 2007) for Turkish meat balls, who observed decrease in all sensory attributes on addition of wheat bran and oat bran.

Table 3. Physico-chemical and proximate composition of *Rista* containing hydrated wheat bran. (Mean ± S.E.)

Parameters (on % basis except pH)	Treatments			
	T_0	T_1	T_2	T_3
Emulsion stability	87.20 ± 0.61^{a}	92.08 ±0.85^{b}	95.04 ±0.22^{c}	98.67±0.33^{d}
Cooking yield	89.10 ± 0.59^{a}	95.22 ± 1.14^{b}	96.60 ±0.75^{bc}	98.69±0.55^{c}
pH	6.26 ± 0.04	6.27 ± 0.03	6.31 ±0.03	6.34 ±0.03
Moisture	71.47 ±0.81^{ab}	69.65 ± 0.81^{a}	70.14 ±1.02^{ab}	72.68±0.85^{b}
Protein	16.97 ± 0.16	17.33 ± 0.37	16.92 ± 0.19	14.85 ±1.75

Fat	8.95 ± 0.09^{b}	8.62 ± 0.10^{b}	8.59 ± 0.32^{b}	7.18 ± 0.56^{a}
Ash	2.11 ± 0.05	2.29 ± 0.15	2.21 ± 0.13	2.03 ±0.08
Dietary fibre	0.21 ± 0.009^{a}	1.09 ± 0.04^{b}	2.26 ± 0.004^{c}	3.02 ±0.07^{d}

Mean ± S.E with different superscripts differ significantly(P<0.05).
N = 6 except for cooking yield and emulsion stability in which N = 3

Table 4. Texture profile Analysis of Effect of *Rista* incorporated with Hydrated wheat bran (HWB) (Mean ± S.E.)

Parameters	Treatments			
	T_0	T_1	T_2	T_3
Hardness (N)	19.51±**0.052**^{a}	20.56±0.11^{b}	21.67±**0.03**^{c}	22.86±0.03^{d}
Cohesiveness	0.39±**0.03**	0.37 ±0.03	0.35 ±0.03	0.32 ±0.02
Springiness (mm)	8.13 ±0.003 ^{d}	7.91 ±0.004 ^{c}	7.24 ± 0.005^{b}	6.97 ±0.008^{a}
Gumminess (N)	7.94 ± 0.011^{a}	8.43 ± 0.009^{b}	9.12±0.004^{c}	9.91 ±0.004 ^{d}
Chewiness (J)	51.10 ±0.004^{a}	53.95±0.01 ^{b}	55.88±0.39^{c}	58.12 ± 0.23^{d}
Resilience	0.79 ±0.02^{b}	0.76 ±0.02^{ab}	0.73 ±0. 02^{ab}	0.70 ± 0.02^{a}

Mean ± S.E with different superscripts differ significantly(P<0.05).
N = 6

Table 5. Effect of hydrated wheat bran (HWB) incorporated *Rista* on the colour (Mean ± **S.E.**)

Parameters	Treatments			
	T_0	T_1	T_2	T_3
Lightness (L)	35.53±0.004^{a}	36.92±0.004^{b}	37.53±0.004^{c}	38.23±0.004^{d}
Redness (a)	7.81±0.005^{d}	7.02 ± 0.003^{c}	6.72 ±0.003^{b}	6.22±0.003^{a}
Yellowness (b)	11.12±0.002^{a}	11.96 ± 0.008^{b}	12.53± 0.003^{c}	13.05 ± 0.17^{d}

Mean ± S.E with different superscripts differ significantly(P<0.05).
N = 6

Table 6. Effect of *hydrated* wheat bran (HWB) as a source of dietary fibre on the sensor quality of *Rista* (Mean ± S.E.)

Parameters	Treatments			
	T_0	T_1	T_2	T_3
Appearance	7.53 ± 0.14^{c}	7.49 ± 0.13^{bc}	7.44 ± 0.14^{b}	6.31 ± 0.24^{a}
Flavour	7.42 ± 0.11^{c}	7.35 ± 0.13^{b}	7.33 ± 0.17^{b}	6.54 ± 0.14^{a}
Juiciness	7.48 ± 0.12^{c}	7.40 ± 0.15^{b}	7.38 ± 0.21^{b}	6.63 ± 0.23^{a}
Texture	7.40 ± 0.11^{a}	7.43 ± 0.15^{ab}	7.46 ± 0.08^{b}	7.54 ± 0.17^{c}
Mouth coating	7.51 ± 0.15^{b}	7.49 ± 0.14^{b}	7.47 ± 0.12^{b}	6.72 ± 0.25^{a}
Binding	7.11 ± 0.11^{a}	7.23 ± 0.20^{b}	7.39 ± 0.21^{c}	7.52 ± 0.11^{d}
Saltiness	7.20 ± 0.13	7.18 ± 0.24	7.15 ± 0.13	6.98 ± 0.25
Overall acceptability	7.58 ± 0.15^{c}	7.49 ± 0.17^{b}	7.44 ± 0.13^{b}	6.72 ± 0.20^{a}

Mean ± S.E with different superscripts differ significantly(P<0.05).
N = 15

Gravy

The pH, protein, fat, and ash values in the gravies of *Rista* decreased with the addition of HWB whereas, the moisture values increased with the addition of HWB. The decrease of protein, fat, and ash content from T_0 to T_3 in gravy might be due to the formation of tight gel and better binding in wheat bran formulated balls on cooking, which might have prevented the ingression of protein, fat and ash towards the gravy.

Organoleptic evaluation revealed that all the sensory attributes like appearance, flavour, consistency, mouth coating, saltiness and overall acceptability showed a non-significant (p>0.05) decreasing trend with increase in level of HWB. Overall, panellists did not detect any major differences among the products. The results are in agreement with Hussain (2011), who reported no major difference in the sensory attributes of treatments as compared to the control.

Conclusions

Functional *Rista* can be efficiently prepared by decreasing the fat content and addition of wheat bran without any adverse effects. Moreover, wheat bran in the *Rista* improved the overall nutritive, sensory, and dietary fibre properties of functional *Rista*.

Table 7. Physico-chemical and proximate composition of *Rista gravy* containing hydrated wheat bran (HWB). (Mean ± **S.E.**)

Parameters (on % basis except pH)	Treatments			
	T_0	T_1	T_2	T_3
pH	6.28±0.03	6.26±0.04	6.22±0.03	6.19±0.03
Moisture	80.12±0.034	80.92±0.011	81.33±1.50	81.73±0.09
Protein	2.43±0.01^{b}	2.40±0.02^{ab}	2.38±0.02^{ab}	2.34±0.04^{a}
Fat	11.19±0.79	11.12±0.52	11.05±0.58	10.97±0.58
Ash	2.61±0.02^{c}	2.57±0.02^{bc}	2.53±0.03^{ab}	2.47±0.03^{a}

Mean ± S.E with different superscripts differ significantly ($P<0.05$).
N = 6

Table 8. Sensory evaluation of *Rista* gravy containing hydrated wheat bran (HWB). (Mean ± **S.E.**)

Parameters	Treatments			
	T_0	T_1	T_2	T_3
Appearance	7.40±0.19	7.33±0.19	7.20±0.22	7.13±0.17
Flavour	7.67±0.13^{b}	7.53±0.17^{b}	7.26±0.15^{ab}	7.06±0.15^{a}
Consistency	7.40±0.16	7.33±0.13	7.20±0.14	7.13±0.13
Mouth coating	7.27±0.12	7.20±0.14	7.13±0.13	7.07±0.18
Saltiness	7.27±12	7.27±0.15	7.20±0.11	7.13±0.13
OA	7.80±0.11^{b}	7.60±0.13^{ab}	7.53±0.13^{ab}	7.33±0.16^{a}

Mean± **S.**E with different superscripts differ significantly($P<0.05$).
N = 15

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