Asian Journal of Chemistry Vol. 19, No. 3 (2007), 2353-2361

Effects of Cereal Bran Addition on Chemical Composition, Cooking Characteristics and Sensory Properties of Turkish Meatballs¶

ELIF EBRU YASARLAR, ORHAN DAGLIOGLU* and ISMAIL YILMAZ
Department of Food Engineering, Faculty of Agriculture
Namik Kemal University, 59030 Tekirdag, Turkey
Fax: (90)(282)2931480; Tel: (90)(282)2931442 Ext: 129
E-mail: odaglioglu@tu.tzf.edu.tr

In this study, cereal brans (oat, maize, rye and wheat) were used as dietary fibre source in the production of meatballs. The effects of bran addition on chemical composition, weight losses, dietary fibre content, colour (L, a and b values) and sensory properties of Turkish type meatballs were studied. Meatball samples were produced with four different formulations including of 5, 10, 15 and 20 % bran addition and bran added samples were compared with the control meatballs. The control meatballs had the highest weight losses. Meatballs with added bran had lower L, a and b values than control samples. There was significant decrease ($p < 0.05$) among sensory properties of meatballs in respect to bran addition. Control samples and 10 % corn bran added samples had the highest overall acceptability scores and 15 % of corn bran addition also led to acceptable products.

Key Words: Meatball, Chemical composition, Cereal bran, Sensory properties.

INTRODUCTION

Fibre addition in meat products is on the increase nowadays, due to its technological use and benefits to human health[1]. Increased proportions of fibre in foods are known to reduce the risk of cancer of the colon, obesity, cardiovascular diseases and several other disorders[2]. Several dietetic fibres have been used in meat products not only to determine their possible beneficial effects on health, but also as potential fat substitutes[3]. Whole grains contain fibre and a number of beneficial phytochemicals. It is the combined action of these components that effectively protects against disease.

¶Abstracted from Master Thesis of Elif Ebru Yasarlar.

Fibre is that part of the foods that cannot be digested by humans. While plant foods contain fibre, dairy products and animal products such as meat, fish, eggs, *etc.* do not contain anyone of them.

Many diseases of public health significance, including obesity, cardiovascular disease, type 2 diabetes, as well as constipation, can be prevented or treated by increasing the amounts and varieties of fibre-containing foods in the diet. Increases in fibre consumption are also recommended throughout the lifecycle, including children and elderly persons. The recommended daily intake for total fibre for adults and younger was set at 38 g for men and 25 g for women, while for men and women over 50 years it is 30 and 21 g of fibre per day, respectively, due to decreased consumption of food[4].

Wheat bran, barley and barley bran were used as replacements for fat in beef sloppy-joes[5]. These fibres added products were found to be inferior in flavour, juiciness, mouthfeel and overall acceptability. Bloukas and Paneras[6] also found that low fat frankfurters with 3 % added rice bran negatively affected the flavour and overall acceptability.

Sugar beet, oat and pea fibres and their combinations with potato starch and polydextrose were incorporated unhydrated into ground beef formulated for 5 and 10 % beef patties[7]. Texture traits were improved for low fat patties but juiciness traits were reduced most by the added ingredients.

Many researchers have reported the addition of plant proteins such as soyabean[7-10], sunflower protein[11], wild rice[12], wheat protein[13,14], corn germ protein[15,16], common bean flour[17], corn flour[18] oat bran[19], rye bran[20], wheat bran[21] and hazelnut pellicle[22] as binders and extenders in various meat products including sausages, frankfurters, meatballs, *etc*.

The aim of this study was to evaluate the effect of adding different levels of various brans on the chemical composition, weight losses, colour, dietary fibre, firmness and sensory properties of meatballs.

EXPERIMENTAL

Oat bran, rye bran, wheat bran and corn bran were added in to the meatball samples as dietary fibre sources and each bran were incorporated at the level of 5, 10, 15 and 20 %, respectively. Meatball samples were produced according to following traditional recipe. The veal (including 20.45 % fat) was grounded and different seasonings (ground black pepper 0.1 %, red pepper 2% and cumin 0.4%) and some other ingredients (onion 3 %, garlic 0.5 % and salt 2 %) were added. The mixture was kneaded for 15 min by hand and obtained meatball dough was divided into five equal portions. The first portion was used as control sample. All bran samples were obtained from POLEN Company, Istanbul, Turkey. Each portion was kneaded for additional 15 min to obtain a homogenous dough. Meatball doughs were stored in a cold room (4ºC) for 1 d and then shaped into 2 cm

diameters meatballs with a weight of 18-20 g before cooking. The meatball samples were cooked in preheated (160ºC) electric grill and cooked 3 min on one side, turned over, cooked 3 min.

Moisture, protein, fat, salt and dietary fibre contents and pH measurements were done according to the methods described by AOAC[23].

A DP-900 D25 Aoptical Sensor Reston (Viriginia, USA) was used to determine Hunter Lab colour values and the evaluation was done according to AOAC[24].

An instron universal testing machine (Model 1140) was used to determine the texture of meatballs[25] using a 500 kg load at 20 mm/min.

Samples were weighed before and after cooking. Total weight loss in meatballs after cooking was expressed as weight losses.

Sensory evaluation was conducted according to the testing procedures of AMSA[26] and IFT[27]. Meatball samples were cooked to 80ºC internally. Meatball samples were served in a random order at a temperature of approximately 60ºC to a trained consumer panel of 15 volunteers from the food engineering department. Samples were evaluated for firmness (9 = extremely firm, 1 = extremely soft), flavour intensity (9 = extremely strong, 1 = extremely weak to unpleasant), juiciness (9 = extremely juicy, 1 = extremely dry), overall palatability (9 = palatable, 1 = unpalatable) using a 9-point hedonic scale. Each attribute was discussed and tests were initiated after panelists were familiarized with the scales.

The data obtained from three replications were analyzed by ANOVA using the SPSS statistical package program and differences among the means were compared using the Duncan's Multiple Range test[28].

RESULTS AND DISCUSSION

Moisture: The chemical composition of the meatballs are shown in Table-1. The control meatballs had the highest ($p < 0.05$) moisture content. On the other hand the meatballs produced with the addition of 20 % corn bran had the lowest ($p < 0.05$) moisture content. The moisture contents of the samples decreased with more bran addition. The control meatball samples were under the Turkish Uncooked Meatball Standard limits[29] in respect to moisture content. According to this standard, all meatballs are allowed up to the 65 % moisture content. More recently, Yilmaz[21] reported that meatballs added wheat bran had 58.13-66.82 % moisture, 16.21-19.26 % protein, 2.34-3.34 % ash and 1.7-2.0 % salt. Various researchers[19,20,30,31] also reported similar results in the meatball samples.

Protein: The differences among the protein contents of the meatballs were significant ($p < 0.05$). The lowest protein content was obtained from the control meatball sample. The protein content of all meatballs were within the limits of Turkish Uncooked Meatball Standard. Similar results were reported by many authors[19,32].

TABLE-1
CHEMICAL COMPOSITION OF BRAN ADDED AND CONTROL MEATBALL SAMPLES

Samples	%	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Salt (%)	Fibre raw meatball (%)	Fibre cooked meatball (%)
Wheat bran	5	55.89cd	16.45hı	18.63a	2.49de	1.98ab	2.47j	3.87l
	10	53.75efg	16.65fgh	18.41ab	2.62bcde	1.96bcd	4.11g	5.51h
	15	52.80fghı	17.08ef	16.95c	2.82abc	1.94bcdef	6.25d	7.48d
	20	51.67hı	18.23ab	15.77d	2.89ab	1.91efg	8.34b	9.75c
Rye bran	5	56.47cd	16.50ghı	17.74b	2.48e	1.95bcde	1.52l	2.13n
	10	54.72def	16.91efgh	16.19d	2.55cde	1.95bcde	3.08ı	4.81j
	15	53.36efgh	17.38de	14.23e	2.74abcde	1.91efg	4.66f	5.37ı
	20	52.22ghı	18.44a	13.04f	2.78abcd	1.88g	6.17d	7.34e
Oat bran	5	59.00b	16.05ıj	17.94b	2.78abcd	1.97bc	1.40l	2.01n
	10	57.84bc	16.55ghı	16.12d	2.90ab	1.92defg	1.92k	3.22m
	15	55.20de	16.97efg	14.58e	2.88ab	1.92defg	3.29h	4.78j
	20	53.82efg	17.86bcd	12.25g	3.02a	1.90fg	4.70f	5.91g
Corn bran	5	56.39cd	15.88jk	15.93d	2.70bcde	1.95bcde	2.90ı	4.10k
	10	56.26cd	16.42hı	14.78e	2.62bcde	1.94bcdef	5.10e	7.13f
	15	55.22de	17.70cd	12.57fg	2.73abcde	1.93cdef	7.62c	9.91b
	20	50.57ı	18.05abc	11.36h	2.63bcde	1.90fg	9.86a	10.98a
Control		63.42a	15.46k	18.80a	1.85f	2.02a	0.00m	0.00o
Min:		50.57	15.46	11.36	1.85	1.88	0.00	0.00
Max:		63.42	18.44	18.80	3.02	2.02	9.86	10.98
Average		55.21	16.98	15.61	2.67	1.94	4.32	5.55

Means within the same row with different superscripts are significantly different ($p < 0.05$).

Fat content: The fat contents of the samples were given in Table-2. The most effective method in lowering calorie levels is to reduce the fat content in meat products. Rye bran addition at the level of 20 % resulted in a significant ($p < 0.05$) reduction in the fat content. Therefore, the highest fat content was obtained from the control meatballs but the values for all samples were within the limits of Turkish Uncooked Meatball Standard. Yilmaz[20,21] reported similar results in the meatball samples. Rye consumption has been reported to inhibit breast and colon tumor growth in animal models, lower glucose responses in diabetics, and lower the risk of death from coronary heart disease[33].

Salt content: The salt content was lowest in 20 % rye bran added sample and the highest in control meatballs ($p < 0.05$). The salt content of 20 % rye bran added meatballs was 1.88 % and that of control meatballs 2.02 %. On the other hand, all the samples except the control meatballs, contained less than 2 % salt that is the maximum level allowed in Turkish

Uncooked Meatball Standard. Similar results were reported by Yilmaz *et al.*[30,31].

TABLE-2
QUALITY CHARACTERISTICS OF BRAN ADDED AND CONTROL MEATBALL SAMPLES

Samples	%	Weight loss	L value	a value	b value	a/b	Firmness raw meatball	Firmness cooked meatball
Wheat bran	5	14.80c	37.14ıj	8.55g	14.43d	0.59cd	4.75g	5.10ı
	10	11.29g	37.44ıj	6.40k	13.15e	0.59cd	5.33d	5.32g
	15	7.72j	39.95fgh	4.58n	12.97e	0.35h	5.75c	5.91e
	20	7.33k	38.35hı	5.58m	12.45e	0.45efgh	6.15b	6.42d
Rye bran	5	16.36b	37.41ıj	8.64f	14.41d	0.60cd	3.22m	4.10l
	10	13.45e	39.46ghı	8.62f	14.63d	0.59cd	3.80k	4.63j
	15	12.65f	39.45ghı	7.29ı	14.76d	0.49defg	4.47ı	5.22h
	20	9.92h	42.31def	6.28l	15.09cd	0.42fgh	5.10e	5.80f
Oat bran	5	14.21d	40.10fgh	8.48h	15.16cd	0.56de	4.70h	5.25g
	10	12.82f	44.97bc	9.06d	16.58a	0.55de	5.75c	6.78c
	15	9.79h	46.13b	7.17j	15.19cd	0.47efg	6.08b	7.38b
	20	8.54ı	48.62a	6.24l	15.67bc	0.40gh	8.04a	8.63a
Corn bran	5	16.50b	39.99fgh	10.62c	15.10cd	0.70bc	3.75l	4.20k
	10	12.68f	40.81efg	12.15a	15.88abc	0.76ab	4.08k	4.47k
	15	11.33g	42.75cde	8.59fg	16.32ab	0.53def	4.35j	4.65ı
	20	9.83h	44.06bcd	8.91e	16.50ab	0.51defg	4.95f	5.10ı
Control		18.82a	35.47j	11.61b	14.39d	0.83a	5.34d	5.74g
Min:		7.33	35.47	4.58	12.45	0.35	3.22	4.10
Max:		18.82	48.62	12.15	16.58	0.83	8.04	8.63
Average		12.24	40.85	8.16	14.86	0.55	4.76	3.21

Means within the same row with different superscripts are significantly different ($p < 0.05$)

Ash content: The statistical analyses results indicated that ash contents of the samples were significantly ($p < 0.05$) affected by bran addition. Ash contents increased with more bran addition. The highest value was obtained in 20 % of oat bran added samples and the lowest in the control meatballs.

Dietary fibre: The differences between the dietary fibre contents of the meatballs were significant ($p < 0.05$). The lowest dietary fibre content was obtained from the control meatball sample. Dietary fibre contents increased with more bran addition. The highest value was obtained in 20 % of corn bran added samples and the lowest in the control meatballs (Table-1).

TABLE-3
SENSORY PROPERTIES OF BRAN ADDED AND CONTROL MEATBALL SAMPLES

Samples	%	Colour	Taste	Juiciness	Off flavour	Flavour	Texture	Overall Accept-ability
Wheat bran	5	6.00e	6.42c	5.57e	6.42cde	6.28d	5.83e	6.09d
	10	6.57c	5.00g	5.28f	6.14de	5.28g	5.14g	5.56e
	15	5.85e	4.71h	4.14g	6.24cde	5.00h	4.57h	4.97f
	20	4.57g	3.14k	3.57h	4.18h	3.71ı	3.57ı	3.74h
Rye bran	5	6.57c	6.13d	5.57e	6.47cd	6.00e	6.14d	6.19d
	10	5.85e	5.14fg	5.14f	6.00e	5.43fg	6.02de	5.06f
	15	6.85b	5.00g	5.28f	6.14de	5.42fg	5.28fg	5.66e
	20	5.85e	5.28f	6.28d	5.57f	5.42fg	5.42f	5.64e
Oat bran	5	5.42f	4.14ı	4.14g	5.00g	5.57f	3.57ı	4.64g
	10	4.57g	3.42j	2.85l	3.28ı	3.14j	3.57ı	3.47ı
	15	4.71g	2.71l	2.85l	2.71j	3.00j	3.57ı	3.26ı
	20	3.00h	2.14m	2.71l	2.42j	2.42k	2.57j	2.54k
Corn bran	5	6.57c	6.28cd	6.71c	6.57c	6.42d	6.57c	6.52c
	10	7.57a	7.11b	7.00b	7.28b	7.14bc	7.28a	7.26b
	15	7.42a	7.14b	7.14ab	7.28b	7.28ab	7.28a	7.27b
	20	6.28d	5.54e	6.42d	7.14b	7.00c	6.85b	6.57c
Control		6.85b	7.57a	7.28a	8.00a	7.42a	7.42a	7.43a
Min:		3.00	2.14	2.71	2.42	2.42	2.57	2.54
Max:		7.57	7.57	7.28	8.00	7.42	7.42	7.43
Average		5.91	5.11	5.17	5.70	5.41	5.33	5.40

Means within the same row with different superscripts are significantly different ($p < 0.05$).

Colour: The Hunter L, a and b values were shown in Table-2. Results of statistical analyses indicated that samples Hunter L, a and b values were significantly ($p < 0.05$) affected by the addition of bran. Meatball lightness, as measured by Hunter-L value, increased with more bran addition. Highest L values (lightness) were observed for 20 % addition oat bran, which means that addition of oat bran resulted in a lighter-coloured product.

Values for a (redness) were also different ($p < 0.05$) for different levels of bran and starting at 11.61 in the control group ($p < 0.05$), meatball redness generally decreased with more bran addition. Similar results were reported by others also[19,34].

All values for b were higher ($p < 0.05$) in corn, rye and oat bran treatment groups than the controls. Corn, oat and rye bran addition appeared to increase product yellowness in meatballs when compared with the control and wheat bran added samples. This might be as a result of carotenoid pigments of rye, oat and corn bran. Other workers[19,35] also obtained similar

results in oat fibre added of frankfurters and meatballs in respect to yellowness.

Weight losses: The differences among the weight losses of the meatballs were significant ($p < 0.05$). High fat meatballs had the highest weight losses (Table-2). The lowest weight losses was obtained from the 20 % wheat bran samples. The highest weight losses was from the control meatball sample, due to the high loss of fat and moisture during cooking. The weight losses of the samples decreased with more bran addition. Similar results were also reported[3,20-22,36].

Firmness: Firmness increased with more bran addition. The control meatballs had the lowest ($p < 0.05$) firmness value. On the other hand, the meatball produced with the addition of 20 % rye bran had the highest ($p < 0.05$) firmness value. Yilmaz and Daglioglu[19] found similar results in oat bran added meatball samples.

Sensory analysis: Sensory traits for cooked meatballs with different bran levels are shown in Table-3. Corn bran (10 %) produced the highest colour scores (7.57). Increasing the oat bran level resulted in meatball with decreased colour scores with the lowest values (3.00) noted in products formulated to contain 20 % oat bran ($p < 0.05$). The control samples also had the highest juiciness and flavour scores and as the bran content increased, the scores for juiciness and flavour decreased to 2.71 and 2.42 in 20 % oat bran added samples, respectively. The mean values of colour, juiciness and flavour were evaluated as overall acceptability. The highest scores were recorded for the control, 10 % corn bran and 15 % corn bran meatballs as 7.43, 7.26 and 7.27, respectively. Overall acceptability scores were also decreased as the bran content increased ($p < 0.05$). Also, increasing the bran amount might cause less mastication and mask the meat flavour. Yilmaz[20] have reported that there was a significant difference ($p < 0.05$) among the rye bran added meatballs in respect to sensory properties. Yilmaz[21] has reported a similar results in a wheat bran added meat balls. According to Grigelmo-Miguel *et al.*[37], reductions of fat content decreased, but peach dietary fibre addition increased the acceptability of low-fat high-dietary fibre frankfurters. Mansour and Khalil[3] reported that, overall palatability of low-fat beef burgers were not affected by the addition of wheat fibres.

Conclusion

The addition of bran sources into the meatballs at the levels of 5, 10, 15 and 20 %, respectively would improve nutritional value and health benefits. Bran addition was found to significantly affect certain quality parameters of the meatballs. On the other hand, the reduction in weight losses of meatball samples was improved with bran addition. Meatballs added with bran had lower L, a, b values than control samples. There was

significant decrease among sensory properties of meatballs in respect to bran addition. Control samples and 10 % corn bran added samples had the highest overall acceptability scores, and 15 % of corn bran addition also led to acceptable products. According to these results, 10 % of corn bran addition can be recommended in the traditional meatball production as a dietary fibre source.

REFERENCES

1. S. Vendrell-Pascuas, A.I. Castellote-Bargallo and M.C. Lopez-Sabater, *J. Chromatogr. A*, **881**, 591 (2000).
2. National Cancer Institute, US Department of Health and Human Services, NIG Pub. 85-2711(1984).
3. E.H. Mansour and A.H. Khalil, *Food Res. Internat.*, **30**, 199 (1997).
4. J. Slavin, *J. Food Composit. Anal.*, **16**, 287 (2003).
5. T.R. Vosen, R.W. Rogers, J.D. Halloran, J.M. Martin and T. Armstrong, *J. Muscle Foods*, **4**, 71 (1993).
6. J.D. Bloukas and E.D. Paneras, *J. Muscle Foods*, **7**, 109 (1996).
7. E.S. Troutt, M.C. Hunt, D.E. Johnson, J.R. Claus, C.L. Kastner and D.H. Kropf, *J. Food Sci.*, **57**, 19 (1992).
8. H.S. Gujral, A. Kaur, N. Singh and S.N. Sodhi, *J. Food Eng.*, **53**, 377 (2002).
9. Z. Pietrasik and Z. Duda, *Meat Sci.*, **56**, 181 (2000).
10. M. Serdaroglu and M. Sapanci-Özsümer, *Electr. J. Pol. Agric. Uni. Series, Food Sci. Tech.*, **6** (2003).
11. R.B.H. Wills and M. Rabirullah, *J. Food Sci.*, **46**, 1657 (1981).
12. P.L. Minerich, P.B. Addis, J. Epley and C. Bingnam, *J. Food Sci.*, **56**, 1154 (1991).
13. R. Gnanasambandam and J.F. Zayas, *J. Food Sci.*, **57**, 829 (1992).
14. F.P. Bejesano and H. Corke, *Meat Sci.*, **50**, 343 (1998).
15. C.S. Lin and J.T. Jayas, *J. Food Sci.*, **52**, 545 (1987).
16. F.J. Zayas and C.S. Lin, *J. Food Sci.*, **53**, 1587 (1988)
17. T. Dzudie, J. Scher and J. Hardy, *J. Food Eng.*, **52**, 143 (2002).
18. M. Serdaroglu and Ö. Degirmencioglu, *Meat Sci.*, **68**, 291 (2004).
19. I. Yilmaz and O. Daglioglu, *Meat Sci.*, **65**, 819 (2003).
20. I. Yilmaz, *Meat Sci.*, **67**, 245 (2004).
21. I. Yilmaz, *J. Food Eng.*, **69**, 369 (2005).
22. S. Turhan, I. Sagir and N.S. Üstün, *Meat Sci.*, **71**, 312 (2005).
23. AOAC Official Methods for the Analysis, Association of Official Analytical Chemists, Arlington Washington DC, edn. 15 (1990).
24. AOAC Official Methods for the Analysis, Association of Official Analytical Chemists, Arlington Washington DC, edn. 14 (1984).
25. J.G. Bloukas and E.D. Paneras, *J. Food Sci.*, **58**, 705 (1993).
26. AMSA, Guidelines for Cookery and Sensory Evaluation of Meat, American Meat Science Association, Chicago, IL (1978).
27. IFT, Guidelines for the Preparation and Review of Papers Reporting Sensory Evaluation Data, *J. Food. Sci.*, **60**, 210 (1985).
28. I. Soysal, Principles of Biometric Analysis, T. Uni. Tekirdag Zir. Fak. Yay. No: 95, Tekirdag (1992) (In Turkish).
29. TSE, Pismemis Kofte Standardi (Turkish Uncooked Meatball Standard, TS 10581) Turk Standartlari Enstitusu, Ankara (1992).
30. I. Yilmaz and M. Demirci, *T. Uni. Tekirdag Zir. Fak. Derg.*, **4**, 17 (1995) (In Turkish).

31. I. Yilmaz, T. Uni. Zir. Fak. Tekirdag, p. 204 (1998).
32. S.Y. Hsu and S.H. Yu, *J. Food Eng.*, **39**, 123 (1999).
33. M.J. Davies, E.A. Bowey, H. Adlercreutz, I.R. Rowland and P.C. Rumbsy, *Carcinogenesis*, **20**, 927 (1999).
34. K.W. Lin and H.Y. Huang, *Meat Sci.*, **65**, 749 (2003).
35. E. Hughes, S. Cofrades and D.J. Troy, *Meat Sci.*, **45**, 273 (1997).
36. E.T. Anderson and B.W. Berry, *Food Res. Internat.*, **34**, 689 (2001).
37. N. Grigelmo-Miguel, M.I. Abadias-Seras and O. Martin-Belloso, *Meat Sci.*, **52**, 247 (1999).

(*Received*: 12 June 2006; *Accepted*: 8 November 2006) AJC-5254