EVALUATION OF QUALITY CHARACTERISTICS LOW FAT BUFFALO MEAT COOKIES INCORPORATED WITH POPPY SEEDS (*PAPAVER SOMNIFERUM*)

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ABSTRACT

The present study was carried out to develop low fat buffalo meat cookies incorporated with Poppy seeds (*Papaver somniferum*) powder (PSP) as fat replacer. Meat cookies were incorporated with 0.5%, 1.0% and 1.5% seed powder to replace 20%, 30% and 40% hydrogenated vegetable fat. The formulation was maintained with addition of water. There was significant difference (P<0.05) between control and treatments for physico-chemical properties except pH, thickness and diameter of cookies. The cooking yield of cookies was comparable upto 1% level, but decreased significantly (P<0.05) at 1.5% PSP incorporation. There was a significant increase (P<0.05) in moisture, protein and ash percentage but fat percentage decreased significantly (P<0.05) with PSP incorporation in cookies. Mean spread ratio decreased significantly (P<0.05) at higher level. There was significant decrease (P<0.05) in all sensory attributes of cookies with PSP incorporation except crispiness. Carabeef cookies with 0.5% ground poppy seeds powder replacing 20% fat had highest overall acceptability scores among all treatments. There was no significant difference in hardness and adhesiveness among control and treatments, but shear force value was significantly higher (P<0.05) at 1.5% level. There was no significant difference for redness, yellowness, chroma and hue angle values. Therefore, on the basis of various physico-chemical properties and sensory evaluation, incorporation of 0.5% poppy seeds powder was selected as optimum to replace 20% of hydrogenated vegetable fat in carabeef cookies without compromising quality attributes.

Keywords: *Bubalus bubalis*, buffalo, buffalo meat, poppy seeds, *Papaver somniferum*, fat replacer, cookies

INTRODUCTION

India is the most important place in terms of buffalo production with more than 50% of buffalo's population all over the world. The world buffalo population is estimated to be 198.88 million, spreading across 42 countries, of which 96.4% are distributed in Asia, 2.9% in Africa, and the rest in Europe and Latin America (FAOSTAT, 2012). In the year 2012 to 2013, India produced 1.53 million tonnes (MT) of buffalo meat of which 1.1 MT were exported to more than 48 countries around the world (APEDA, 2014). Buffalo meat is known

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to be a part of the human diet with a favorable effect on vitality and incidence of diseases as demonstrated by some comparative trials between buffaloes and cattle or other species (de Mendoza *et al*., 2005). Increasing global requirements and the ever-changing consumer demand for sustainable, economically viable, high quality, and healthier meat and meat products warrants the livestock sector to look for an alternative meat animal to feed the burgeoning population (Naveena and Kiran, 2014; Luz *et al*., 2017). Buffalo meat production may be a potential promising market for processing into variety of meat products (communited, snacks, emulsion based etc.) due to nutritive properties in terms of protein, minerals etc., functional properties and excellent palatability attributes (Huerta *et al*., 2016). Most of the cookies available in the market are cereal based with high calorific content. Cereal based snack products lack some essential amino acids like tryptophan, threonine and lysine (Jean *et al*., 1996). Therefore greater interest has been aroused to develop value added protein enriched cookies with incorporation of buffalo meat to overcome the problem of protein energy malnutrition.

Fat is a very important ingredient contributing to the texture, flavour and overall perception of cookies. Fat also imparts richness and tenderness, improving flavour and mouth feel to processed meat products (Pareyt and Delcour, 2008). However, an excess of energy intake and the consequent high amount of fat (especially saturated fat) is associated with health disorders such as obesity, cancer, high blood cholesterol and coronary heart disease (Akoh, 1998). Reducing fat content with fat replacers in meat cookies without affecting the sensory characteristics may be a significant challenge. Poppy seeds (*Papaver somniferum*) are widely used as fat replacer in various meat products (Gok *et al*., 2011). Oil content of poppy is reported to range from 45% to 50% (Özcan and Atalay, 2006). Poppy oil has approximately 73% linoleic, 10% palmitic, and 13% oleic acid as the major fatty acids (Nergiz and Ötles, 1994). Tarancón *et al.* (2015) reported that fat replacement in baked cookies might adversely affect the acceptability in terms of hard texture and sensory attributes. As per Turhan *et al.* (2005), red meat industry has the challenge of developing low-fat meat products formulated to meet dietary needs of consumers. Keeping these views in mind, present study was carried out to develop protein enriched low fat functional cookies with incorporation of buffalo meat powder as protein source and poppy seed powder as fat replacer.

MATERIALS AND METHODS

The experiments were conducted in Division of Livestock Products Technology, Indian Veterinary Research institute, Izatnagar, Bareilly, India. Deboned buffalo meat obtained from freshly slaughtered buffalo (6 to 7 years of age) was procured from local market within 5 to 6 h of slaughter. All visible fascia and external fat was trimmed off and meat portions were made into cuts of approximately 0.5 Kg. The cuts were then packaged separately in low density polyethylene pouches and kept in refrigerator for conditioning for about 24 h. The chilled aged buffalo meat was used for preparation of carabeef powder and remaining meat was shifted to deep freezer (Blue star, FS345, Denmark) for storage at 18±2°C till further use. Refined wheat flour, skimmed milk powder, baking powder, sugar, salt, vanaspati ghee (Dalda) and poppy seeds werwere purchased from local market of Bareilly. Poppy seeds (*Papaver somniferum*)

were dried in oven till constant moisture content and then ground to a consistency of powder. All the chemicals used in the study were of analytical grade and procured standard firms (Qualigen, Hi-Media, SDfine etc.). Low density Polyethylene (LDPE) bags of 60 µ thickness were sourced from local market and sterilized by exposing to U.V. light for 30 minutes before use.

Development of carabeef powder

Boneless meat was minced by passing once through 9 mm plate of presterilized meat mincer. Minced meat was partially cooked by steam cooking for 20 minutes to stabilize protein and to leach out the myogobin and then drained to remove water as much as possible. Minced partially cooked meat was then kept in hot air oven for 16 to 18 h at 50°C to 60°C to remove the residual moisture. The dried meat was finally ground in grinder to have desired consistency of the meat powder. The carabeef powder contained 4% to 5% moisture, 77% to 78% protein, 11% to 13% fat and 4% to 5% ash. This meat powder was then immediately packed in presterilized PET jars.

Preparation of product

The cookies were prepared by following method prescribed by Manohar and Haridas (1999) with slight modifications. Preliminary trails were carried out to standardize carabeef powder and orange pulp fiber level in cookies. In final product, 25% carabeef powder and 10% orange pulp fiber were selected as optimum level for protein and fiber source (Goswami *et al*., 2017). Refined wheat flour, carabeef powder, poppy seeds (*Papaver somniferum*) powder and other ingredients were weighed accurately as per the formulation given in Table 1. All the ingredients were uniformly mixed manually and provided with a desired consistency to prepare dough. Now, the doughs were sheeted on a wooden board with rolling pins. The dough was cut into different desired shapes using cookies moulder. These cookies were baked in hot furnace at 150°C to 160°C for 35 to 40 minutes. The baked cookies were then cooled to room temperature and immediately packaged. Carabeef cookies incorporated with four different levels of dried plum powder 0.5% to 1.5% levels separately during dough preparation to replace 20% to 40% hydrogenated vegetable fat. The formulation of dough was maintained by addition of water replacing refined wheat flour were abbreviated as: C- control carabeef cookies with 0% poppy seed powder, PO1-carabeef cookies with 0.5% poppy seed powder to replace 20% fat, PO2-carabeef cookies with 1.0% poppy seed powder to replace 30% fat and PO3- carabeef cookies with 1.5% poppy seed powder to replace 40% fat. The percentage of dough formulation was maintained by adding water.

Analysis of product

Developed cookies were evaluated for various physico-chemical properties as per standard procedures. The pH of carabeef cookies was determined as per (Trout *et al*., 1992) method. Cooking/baking yield was determined by dividing baked product weight by the raw unbaked weight and multiplying it by100 to express as percent. Physical parameters *viz*., thickness, diameter and spread ratio of baked cookies were measured by methods described by Ajila *et al*. (2008). Proximate parameters like ash, protein, fat, fiber and ash percentage were evaluated as per AOAC (1995). Instrumental textural analysis i.e. hardness and adhesiveness were evaluated measured with the help of instrumental texture profile analyser (TA HD Plus Texture Analyser) as per Bourne

(1978) whereas shear force value was determined as per the method described by Berry and Stiffler (1981). Color values were estimated by Lovibond tintometer (Model F, Greenwich, UK) to determine redness, yellowness, chroma and hue values using the formulae, $\tan^{-1}(b/a)$ (Little, 1975) and $(a^2+b^2)^{1/2}$ (Froehlich *et al*., 1983), respectively where a = red unit, b = yellow unit. Sensory evaluation was carried out by using 8 point hedonic scale with 8 point as extremely desirable and 1 as extremely poor (Keeton, 1983).

Statistical analysis

The data generated from various trials under each experiment were pooled and analyzed by statistical method of one way-ANOVA and Mean±S.E using SPSS Statistics 20.0 software package developed as per the procedure of (Snedecor and Cochram, 1995).

RESULT AND DISCUSSION

Physico-chemical properties

The physico-chemical properties of functional carabeef cookies incorporated with poppy seeds (*Papaver somniferum*) powder are presented in Table 2. There was no significant difference in cooking yield of PO1 and PO2 and the values were comparable to control. The incorporation of poppy seed powder in PO3 brought about significantly higher ($P<0.05$) cooking yield than control, which might be due to higher fat retention and water absorption capacity of poppy seeds. Gok *et al.* (2011) also reported higher cooking yield in ground poppy seeds incorporated meat burgers as compared to control samples. There was a significant increase ($P<0.05$) in moisture, protein and ash percentage with increased level of PSP, however no significant difference was observed between PO2 and PO3 for these proximate parameters. Higher moisture percent in treatments than control might be due to higher moisture retention capacity of poppy seeds, while a higher protein % in treatments might be due to good amount of protein (18.3% to 21.1%) in ground poppy seeds (Bozan and Temelli, 2003). The fat percentage decreased significantly ($P<0.05$) with poppy seed powder incorporation in cookies. Choi *et al.* (2009) also reported significantly lower ($P<0.05$) fat percentage in meat snacks prepared with incorporation of sunflower seed oil. Yilmaz and Daglioglu (2003) reported a decrease in fat content of meat balls having 20% oat bran as an animal fat replacer. Yilmaz (2004) reported about 20% reduction in fat content of meat burgers with 20% rye bran addition. Kamran *et al.* (2003) also observed significant decrease ($P<0.05$) in cookies with rice bran oil incorporation as fat replacer. Mean thickness and diameter values had no significant difference, while spread ratio decreased significantly ($P<0.05$) at higher level of PSP incorporation in PO2 and PO3. There was no significant difference between C and PT1 as well as between PT2 and PT3 for spread ratio. Ganokar and Jain (2014) also observed lower spread ratio of cookies with increased level of flexseed powder. They reported that reduction in spread ratio might be due to increase in protein and dietary fiber percentage with increasing level of flaxseed flour as protein and dietary fiber had more water binding power.

Instrumental textural parameters

The textural properties of functional carabeef cookies incorporated with poppy seeds powder are presented in Table 3. Mean shear force value was significantly higher ($P<0.05$) in PO3 as

Table 1. Formulation of Poppy seeds (*Papaver somniferum*) powder incorporated low fat buffalo meat cookies.

%	C	PO1	PO2	PO3
Carabeef powder	25	25	25	25
Refined wheat flour	15	15	15	15
Fiber source	10	10	10	10
Hydrogenated vegetable oil	17.5	14.00	12.25	10.5
Poppy seed powder	0.0	0.5	1.0	1.5
Water	0.0	3.0	4.25	5.5
Milk powder	10	10	10	10
Sugar	15	15	15	15
Glucose	2.5	2.5	2.5	2.5
Egg albumin	2.5	2.5	2.5	2.5
Vanilla essence	0.75	0.75	0.75	0.75
Baking powder	0.75	0.75	0.75	0.75
Salt	1.0	1.0	1.0	1.0

C- carabeef cookies with 0% poppy seed powder

PO1-carabeef cookies with 0.5% poppy seed powder

PO2- carabeef cookies with 1.0% poppy seed powder

PO3- carabeef cookies with 1.5% poppy seed powder

Table 2. Physico-chemical properties of *Papaver somniferum* powder incorporated low fat buffalo meat cookies (Mean ± SE).

Parameters	OT2	PO1	PO2	PO3	Treatment mean
pH	5.73±0.04	5.71±0.02	5.69±0.02	5.67±0.01	5.70±0.01
Cooking yield (%)	81.74±0.15^{b}	81.88±0.09^{ab}	82.07±0.02^{ab}	82.13±0.04^{a}	81.95±0.05
Moisture (%)	2.17±0.03^{c}	2.35±0.03^{b}	2.55±0.05^{a}	2.69±0.04^{a}	2.44±0.04
Protein (%)	41.23±0.22^{b}	41.65±0.34^{ab}	41.87±0.26^{a}	42.19±0.31^{a}	41.73±0.20
Fat (%)	19.40±0.09^{a}	15.43±0.03^{b}	15.05±0.03^{c}	14.77±0.03^{d}	16.16±0.39
Ash (%)	2.81±0.06^{b}	2.84±0.03^{ab}	2.85±0.02^{b}	2.94±0.01^{a}	2.86±0.01
Thickness (mm)	1.08±0.003	1.09±0.003	1.10±0.003	1.10±0.003	1.09±0.002
Diameter (mm)	55.10±0.03	55.13±0.04	55.08±0.04	55.08±0.08	55.10±0.02
Spread ratio	50.85±0.16^{a}	50.50±0.16^{a}	50.07±0.18^{b}	50.08±0.30^{b}	50.37±0.12

Mean ± SE with different superscripts in a row differ significantly ($P<0.05$).

n = 6 for each treatment

compared to C, however value was comparable upto 1% PSP incorporation. There was no significant difference in hardness and adhesiveness between control and treatments, however Woo *et al*. (1995) reported increase hardness in cottonseed oil incorporated low fat emulsion type sausages. Choi *et al*. (2010) also observed increased hardness and shear force values of pork back fat emulsions developed with the incorporation of grape seed oil and rice bran fiber. Ganorkar and Jain (2014) observed increased hardness and adhesiveness values of cookies upto 15% fat replacement followed by decrease trend in both parameters at higher level of flexseed flour. Nayak and pathak (2017) also observed no significant difference in adhesiveness of chevon patties incorporated with poppy seeds powder. Vel (2015) reported no significant effect on hardness and cohesiveness in Turkish Sucuk prepared with replacement of beef fat with poppy seeds powder.

Color values

Mean color values of functional carabeef cookies incorporated with poppy seeds powder are presented in Table 4. There was no significant difference for mean redness, yellowness, chroma and hue angle values between control and PSP incorporated low fat cookies. Gok *et al.* (2011) also observed no significant difference in *a** values of ground poppy seeds added meat burgers and control, but *b** values increased significantly ($P<0.05$) due to high yellow pigment concentration of ground poppy seed, however Seda (2017) observed significant ($P<0.05$) decrease in L* (lightness) and increase in a* (redness) and b* (yellowness) with incorporation of poppy seeds in biscuits.

Sensory evaluation

Mean sensory scores of functional carabeef cookies incorporated with poppy seeds are presented in Table 5 and Figure 1. Mean color and appearance as well as flavor scores decreased significantly ($P<0.05$) at higher level of PSP in carabeef cookies, however scores of PO1 were comparable with C for both attributes. Gok *et al*. (2011) also observed lower color scores of meat burgers incorporated with poppy seed powder due

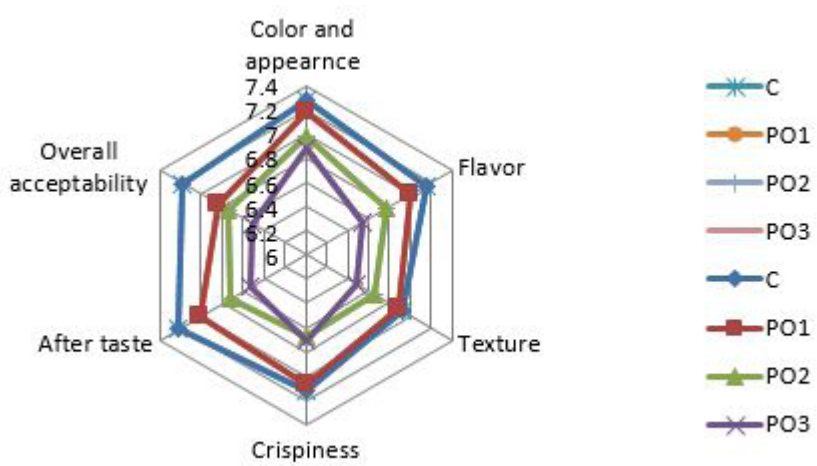

Figure 1. Sensory attributes of *Papaver somniferum* powder incorporated low fat buffalo meat cookies.

Table 3. Instrumental textural parameters of of *Papaver somniferum* powder incorporated low fat buffalo meat cookies (Mean±SE).

Parameters	OT2	PO1	PO2	PO3	Treatment mean
Hardness (N/cm^2)	6.08±0.27	5.64±0.09	5.69±0.09	5.89±0.04	5.82±0.08
Shear force value(kg/cm^2)	$4.16±0.16^{b}$	$4.51±0.05^{ab}$	$4.56±0.07^{ab}$	$4.63±0.08^{a}$	4.47±0.06
Adhesiveness (N/gm)	3.33±0.06	3.22±0.03	3.24±0.06	3.28±0.05	3.27±0.02

Mean ± SE with different superscripts in a row differ significantly (P<0.05).

n = 6 for each treatment

Table 4. Color values of *Papaver somniferum* powder incorporated low fat buffalo meat cookies (Mean±SE).

Parameters	OT2	PO1	PO2	PO3	Treatment Mean
Redness	4.30±0.07	4.28±0.08	4.25±0.07	4.18±0.06	4.25±0.03
Yellowness	3.73±0.08	3.75±0.09	3.76±0.09	3.78±0.10	3.75±0.04
Chroma	5.69±0.12	5.69±0.12	5.67±0.11	5.64±0.11	5.67±0.05
Hue angle	0.82±0.01	0.83±0.01	0.81±0.02	0.78±0.02	0.82±0.01

n = 6 for each treatment

Table 5. Sensory evaluation of *Papaver somniferum* powder incorporated low fat buffalo meat cookies (Mean ± SE).

Parameters	OT2	PO1	PO2	PO3	Treatment mean
Color and appearance	$7.28±0.06^{a}$	$7.18±0.07^{ab}$	$6.98±0.08^{bc}$	$6.88±0.07^{c}$	7.08±0.04
Flavor	$7.15±0.06^{a}$	$7.00±0.06^{ab}$	$6.77±0.06^{bc}$	$6.55±0.09^{c}$	6.87±0.04
Texture	$6.93±0.14^{a}$	$6.89±0.14^{a}$	$6.66±0.10^{ab}$	$6.49±0.07^{b}$	6.74±0.06
Crispiness	7.12±0.08	7.07±0.08	6.67±0.29	6.71±0.07	6.89±0.08
Aftertaste	$7.22±0.06^{a}$	$7.01±0.06^{a}$	$6.73±0.04^{b}$	$6.52±0.07^{b}$	6.87±0.04
Overall acceptability	$7.18±0.05^{a}$	$6.84±0.05^{b}$	$6.74±0.05^{bc}$	$6.51±0.03^{c}$	6.82±0.03

Mean ± SE with different superscripts in a row differ significantly (P<0.05).

n = 21 for each treatment

to its dark yellow color. The scores for texture and aftertaste decreased significantly (P<0.05) with increased level of poppy seed powder, however no significant difference was observed between C and PO1. Lower texture and aftertaste scores at higher level of PSP in PO2 and PO3 might be due to lower fat percentage and somewhat pungent mouth feel after swallowing of cookies as observed by sensory panelists. Similar observations were also reported by Ganorkar and Jain (2014) in cookies prepared by incorporation of flexseed flour. Overall acceptability scores decreased significantly (P<0.05) with poppy seed incorporation in carabeef cookies, while PO1- fiber enriched low fat carabeef cookies with 0.5% ground poppy seeds powder replacing 20% fat received highest overall acceptability scores among all treatments.

CONCLUSION

Addition of poppy seed powder in carabeef cookies had significant effect on fat reduction but sensory scores reduced accordingly at higher level with some pungent flavor. There was no significant change in color and textural parameters of poppy seed powder incorporated buffalo meat cookies. Therefore it can be concluded that poppy seeds powder can be incorporated in carabeeef cookies upto 0.5% to replace 20% of hydrogenated vegetable fat without compromising quality attributes particularly physico-chemical properties and sensory evaluation.

REFERENCES

Ajila, C.M., K. Leelavathi and U.J.S.P. Rao. 2008. Improvement of dietary fiber content and antioxidant properties in soft dough biscuits with the incorporation of mango peel powder. *J. Cereal Sci*., **48**: 319-326.

Akoh, C.C. 1998. Fat replacers. *Food Technology*, **52**: 47-52.

APEDA. 2014. Export of agro and processed food products including meat and meat products. *Agricultural and Processed Food Products Export Development Authority*. Ministry of Commerce, Government of India, India.

Berry, B.W. and D.M. Stiffler. 1996. Effect of electrical stimulation, boiling temperature, formulation and rate of freezing on sensory, cooking, chemical and physical properties of ground beef patties. *J. Food Sci*., **46**: 1103-1106.

Bourne, M.C. 1978. Texture profile analysis. *J. Food Sci*., **32**: 62-67.

Bozan, B. and F. Temelli. 2003. Extraction of poppy seed oil using supercritical CO2. *J. Food Sci*., **68**(2): 422-426.

Choi, Y.S., J.H. Choi, D.J. Han, H.Y. Kim, M.A.L. Hyun-Wook and K.J.Y. Jeong. 2009. Characteristics of low-fat meat emulsion systems with pork fat replaced by vegetable oils and rice bran fiber. *Meat Sci*., **82**: 266-271.

Choi, Y.S., J.H. Choi, D.J. Han, Y.K. Hack, M.A. Lee, W.K. Hyun, J.W. Lee, H.J. Chung and J.K. Cheon. 2010. Optimization of replacing pork back fat with grape seed oil and rice bran for reduced - fat meat emulsion systems. *Meat Sci.*, **84**: 212-218.

De Mendoza, G.M., L.A. de Moreno, N. Huerta-Leidenz, S. Uzcátegui-Bracho, M.J. Beriain and G.C. Smith. 2005. Occurrence of conjugated linoleic acid in longissimus dorsi muscle of water buffalo (*Bubalus bubalis*) and zebu-type cattle raised under

savannah conditions. *Meat Sci.*, **69**: 93-100.

FAOSTAT. 2012. FAO Statistical Yearbook. http://faostat.fao.org/site/291.

Froehlich, D.A., E.A. Gullet and W.R. Usborne. 1983. Effect of nitrite and salt on the colour, flavour and overall acceptability of ham. *J. Food Sci*., **48**: 152-154.

Ganokar, P.M. and R.K. Jain. 2014. Effect of flexseed incorporation on physical, sensorial, textural and chemical attributes of cookies. *Inter. Food Res. J*., **21**(4): 1515-1521.

Gok, V., L. Akkaya, E. Obuz and S. Bulut. 2011. Effect of poppy seed as a fat replacer on meat burgers. *Meat Sci*., **89**(4): 400-404.

Goswami, M., B.D. Sharma, S.K. Mendiratta and V. Pathak. 2017. Development and quality assessment of fiber enriched functional carabeef cookies. *Vet. Pract*., **18**(1): 136-140.

Huerta-Leidenz, N., A. Rodas-González, A. Vidal, J. Lopez-Nuñez and O. Colina. 2016. Carcass cutout value and eating quality of longisssimus muscle from serially harvested savannah-raised Brahman-influenced cattle and water buffaloes in Venezuela. *Anim. Prod. Sci*., **56**(12): 2093-2104.

Jean, I.J., R. Work, M.E. Camire, J. Briggs, A.H. Barrett and A.A. Bushway. 1996. Selected properties of extruded patato and chicken meat. *J. Food Sci*., **61**(4): 783-789.

Kamran, S., S.B. Masood, M.A. Faqir, M. Nasir, R. Rashid and M.N. Qayyum. 2003. Extension of cookies shelf life by using rice bran oil. *Int. J. Agric. Biol*., **4**: 455-457.

Keeton, J.T. 1983. Effect of fat and sodium chloride/phosphate levels on the chemical and sensory properties of pork patties. *J. Food Sci*., **48**: 878-881.

Luz, P.A.C., A.M. Jorge, C.L. Francisco, J.L.M. Mello, C.T. Santos and C. Andrighetto. 2017. Chemical-physcial characteristics of buffalo *(Bubalus bubalis)* meat subjected to different aging times. *Acta Scientiarum. Anim. Sci*., **39**(4): 419-428.

Manohar, S.R. and O.R. Haridas. 1999. Effect of emulsifiers, fat level and type on the rheological characteristics of biscuit dough and quality of biscuits. *J. Sci. Food Agr*., **79**: 1223-1231.

Naveena, B.M. and M. Kiran. 2014. Buffalo meat quality, composition and processing characteristics: Contribution to the global economy and nutritional security. *Animal Frontiers*, **4**(4): 18-24.

Nayak, N.K. and V. Pathak. 2017. Development of low fat chevon patties using poppy seed as fat replacer. *Indian Journal of Small Ruminants*, **23**(2): 236-239.

Nergiz, C. And S. Otles. 1994. The proximate composition and some minor constituents of poppy seeds. *J. Sci. Food Agr*., **66**(2): 117-120.

Özcan, M.M. and C. Atalay. 2006. Determination of seed and oil properties of some poppy (*Papaver somniferum L.*) varieties. *Grasas y Aceites*, **57**(2): 169-174.

Pareyt, B. and J.A. Delcour. 2008. The role of wheat flour constituents, sugar, and fat in low moisture cereal based products: A review on sugar-snap cookies. *Crit. Rev. Food Sci.*, **48**: 824-839.

Seda, Y. 2017. Determination of quality characteristics of biscuits including yellow poppy seed as fat replacer. *International Journal of Secondary Metabolite*, **3**(2): 406-411.

Snedecor, G.W. and W.G. Cochram. 1995.

Statistical Methods, 8th ed. The Iowa State University Press, Ames, Iowa, USA. 593p.

Tarancón, P., A. Salvador, T. Sanz, S. Fiszman and A. Tárrega. 2015. Use of healthier fats in biscuits (olive and sunflower oil): Changing sensory features and their relation with consumers' liking. *Food Res. Int.*, **69**: 91-96.

Trout, E.S., M.C. Hunt, D.E. Johnson, J.R. Claus, C.L. Kastner and D.H. Kropt. 1992. Characteristics of low fat ground beef containing texture modifying ingredients. *J. Food Sci.*, **57**(1): 19-24.

Turhan, S., I. Sagir and N.S. Ustun. 2005. Utilization of hazelnut pellicle in low-fat beef burgers. *Meat Sci*., **71**(2): 312-316.

Vel, G. 2015. Effect of replacing beef fat with poppy seed oil on quality of Turkish sucuk. *Korean J. Food Sci. An.*, **35**(2): 240-247.

Woo, M.J., K.T. Lee and C.J. Kim. 1995. Quality characteristics of emulsion-type sausages manufactured with cottonseed oil. *Journal of the Korean Society of Food Science and Nutrition*, **15**(2): 187-191.

Yilmaz, I. 2004. Effects of rye bran addition on fatty acid composition and quality characteristics of low-fat meatballs. *Meat Sci*., **67**: 245-249.

Yilmaz, I. and O. Daglioglu. 2003. The effects of replacing fat with oat bran on fatty acid composition and physic chemical properties of meat balls. *Meat Sci*., **65**(2): 819-823.