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Comparative Efficiency of Different Fat Replacers to Develop Functional Low Fat Carabeef Cookies

Meena Goswami[1]* , B. D. Sharma[2], S. K. Mendiratta[2], Vikas Pathak [1] and Heena Sharma[3]

[1]College of Veterinary Sciences and AH, DUVASU, Mathura, India-281001

[2] Indian Veterinary Research Institute, Izatnagar, Bareilly, India-243122

[3]National Dairy Research Institute, Karnal, Haryana, India- 132001

ABSTRACT

The present study was carried out to develop functional low fat carabeef cookies with incorporation of different fat replacers viz. Poppy seeds, dried plum pulp powder and guar gum separately at 0.5-1.5% levels to replace 20-40% hydrogenated vegetable fat. The optimum level of each fat replacer was selected as carabeef cookies incorporated with 0.5% poppy seeds powder to replacer 20% fat (PO), carabeef cookies incorporated with 1.5% guar gum powder to replace 40% fat (GT) and carabeef cookies incorporated with 1.0% plum pulp powder to replace 30% fat (PL). These selected levels of each fat replacer were further compared to select the best treatment Final experiment was conducted to evaluate the comparative efficacy of these fat replacers on the basis of various physic-chemical properties and sensory evaluation. There was significant difference ($P<0.05$) in between treatments for all physico-chemical properties except thickness of cookies. Cooking yield, moisture, protein and ash percentage were significantly higher ($P<0.05$) in GT than other treatments. The pH of PL cookies was significantly lower ($P<0.05$) than PO cookies. Diameter and spread ratio were significantly higher ($P<0.05$) in PO, but no significant difference was observed in guar gum and plum pulp powder incorporated carabeef cookies. The color and appearance, crispiness and overall acceptability scores were significantly higher ($P<0.05$) in GT than PO and PL. The hardness and shear force value were significantly higher ($P<0.05$) at 1.5% guar gum level. Redness and hue angle were significantly higher ($P<0.05$) in plum pulp powder incorporated cookies than other treatments. Therefore, GT- carabeef cookies incorporated with 1.5% guar gum to replacer 40% hydrogenated vegetable fat were taken as the most desirable and acceptable treatment.

Keywords: *Carabeef cookies, Fat replacers, Guar gum, Poppy seeds, Plum pulp powder, Consumer acceptance*

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INTRODUCTION

There is a great interest regarding demand for foods with health enhancing properties due to the human health and nutrition correlation. On another side, demand of meat based snacks has been increased potentially due to rapid urbanization, awareness for nutritious and healthy food as well we change in food habits. Utilization of meat and non-meat ingredients in right proportions can enhance health benefits of functional snack products along with right crunch and ease of mastication. Therefore, an attempt has been made to develop low fat meat based snacks i.e. carabeef cookies with delivering more nutritional balance with less calories and more protein. Fat content has a basic effect on various physico-chemical and sensory characteristics as flavour, mouth feel, juiciness, texture, handling, bite, heat transfer etc. (Pearson and Gillett, 1999). Fat reduction has two directions, the first being to use non-fat, energy-low substitutes, and the second being to use polyunsaturated fatty acid (PUFA)-rich marine or plant oils to improve the fatty acid profile of the products (Jimenz et al., 2001). Fat replacers should have the proper properties to mimic the fat globules and retain similar sensorial properties of the modified product compared to control with full fat content. Most fat replacers currently in use are reformulations of previously used meat ingredients. Gums, inulin, maltodextrins, oatrim (hydrolysed oat flour), starches are used as carbohydrate-based fat replacers in meat/poultry products whereas olestra, other lipid (fat/oil) analogs (fried foods) as fat-based replacers. In fish/shellfish products, only other lipid (fat/oil) analogs (fried foods) are used as fat replacers. The fat in foods can be lowered by simple techniques such as dilution with water or substituting with ingredients such as fruit purees or with use of compounds developed by food technologists (Ruthing et al., 2001). Plum-derived food ingredients have been reported to function as antioxidants, antimicrobials, fat replacers and flavourings (Gonzalez et al., 2008). Dried plum puree contains indigenous chemical compounds that serve specific functions in foods, pectin aids in moisture retention, while malic acid enhances flavour and sorbitol acts as a natural humectant (Nunez et al., 2009). Dried plums contain a unique blend of both soluble and insoluble pectins, which serve as a fat replacement in many baked foods without the need for fat-based emulsifiers. Poppy seeds (Papaver somniferum) and guar gum are also 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). Bozan and Temelli (2008) reported that total phenolic content of poppy seed was 930mg/100g. Guar seed endosperm is water soluble gum which is used as stabilizer, emulsifier and thickener in various food products and contributes to 75-85% galactomannan, 8.0-14.0 % moisture, 5.0-6.0% protein, 2.0-3.0% fiber and 0.5-1.0% ash (Kays et al., 2006). Guar gum has great water binding capacity; it prevents ice crystals in frozen products, moisturizes, thickens, stabilizes and suspends many liquid–solid systems, hence used in various dairy and meat products as fat replacer and emulsifying agent (Parija et al., 2001). Fat reduction in meat products due to incorporation of fat replacer may be resulting into products with less mouth coating, hard texture and adverse effects in sensory scores. Development of low fat functional cookies with the most suitable fat replacer without affecting the sensory characteristics may be a significant challenge. Therefore, present study was carried out to select the best fat replacer for development of low fat functional carabeef cookies.

*Corresponding author E-mail address: dr.goswami2008@yahoo.co.in,
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MATERIALS AND METHODS

Deboned buffalo meat obtained from freshly slaughtered buffalo (6-7 years of age) was procured from local market of Bareilly within 5-6 hours of slaughter. The cuts were then packaged separately in low density polyethylene pouches and kept in refrigerator for conditioning for about 24 hours. 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±20C till further use. Refined wheat flour, skimmed milk powder, baking powder, sugar, salt, vanaspati ghee (hydrogenated vegeltable fat), poppy seeds and plums were purchased from local market of Bareilly. Plum pulp was dried in oven till constant moisture content and then ground to a consistency of powder. Poppy seeds were also ground to have powdered form. 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 60µ thickness and PET jars were sourced from local market and sterilized by exposing to U.V. light for 30 minutes before use. They were used for packaging of carabeef cookies and carabeef powder respectively.

Preparation of carabeef meat powder and cookies: 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. Cooked meat was then kept in hot air oven for 16-18 hours at 50-600C to remove the residual moisture. The dried meat was finally ground in grinder to have desired consistency of the meat powder. Meat powder contained 4-5% moisture, 77-78% protein, 11-13% fat and 4-5% ash. This meat powder was then immediately packed in presterilized PET jars.

Meat powder was prepared as per the method outlined by Goswami et al. (2017) and cookies were prepared according to the procedure adopted by Manohar and Haridas (1999) with slight modifications as noted by Goswami et al. (2015). The functionality of carabeef cookies was attempted to improve with incorporation of three different fat replacers i.e. Poppy seeds, dried plum pulp powder and guar gum separately at 0.5-1.5% levels separately during dough preparation to replace 20-40% hydrogenated vegetable fat (Table.1). The formulation of dough was maintained by addition of water replacing refined wheat flour. The optimum level of each fat replacer was selected on the basis of sensory evaluation and these selected fat replacers were compared along with control to select the best treatment on the basis of various physico-chemical properties and sensory evaluation.

Table 1: Formulation of low fat functional cara beef cookies incorporated with different fat replacer

	Control	Fat replacer (0.5%)	Fat replacer (1.0%)	Fat replacer (1.5%)
Carabeef Powder	25	25	25	25
Refined Wheat Flour	15	15	15	15
Orange pulp fiber	10	10	10	10
Hydrogenated vegetable oil	17.5	14	12.25	10.5
Fat replacer	0	0.5	1.0	1.5
Water	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	1	1	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 150-1600C for 35-40 minutes (Kumar et al., 2016). The baked cookies were then cooled to room temperature and immediately packaged.

Analysis of product: Developed cookies were evaluated for various physico-chemical properties as per standard procedures. The pH of 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 by 100 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 composition like ash, protein, fat, fiber and ash percentage were evaluated as per AOAC (1995). Textural profile 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 (a2+b2)1/2 (Froehlich et al., 1983), respectively where a = red unit, b = yellow unit. Sensory evaluation was carried out by using eight-point hedonic scale with 8 point as extremely desirable and 1 as extremely poor (Keeton, 1983). A sensory panel (semi-trained) of seven judges drawn from postgraduate students and scientists of division of LPT, Indian Veterinary Research Institute, Izatnagar, Bareilly, India, were requested to evaluate the product for different quality attributes viz., color and appearance, texture, flavor, crispiness, aftertaste and overall acceptability in sensory room of department.

Statistical analysis: A total of three replications were carried out with each analysis done in duplicate (n =6), except sensory studies where seven sensory panellists did sensory evaluation three times and n=21 observations were recorded for each sensory attribute. 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 and means were compared by using Dunkan's multiple range test.

RESULTS AND DISCUSSIONS

Meat products are poor source of fiber, therefore preliminary trails were carried out to standardize meat powder and orange pulp fiber (OPF) level in cookies as protein and natural fiber source. OPF was obtained by drying of orange pulp after removal of juice in hot air oven at 65-700C to constant moisture level and then grounded to have powder like consistency. In final product, 50% carabeef powder and 10% orange pulp fiber were selected as optimum level for protein and fiber source (Goswami et al., 2017). The functionality of carabeef cookies were further improved with incorporation of three different fat replacers i.e. Poppy seeds powder (PSP), dried plum pulp powder (PPP) and guar gum powder (GGP) separately at 0.5-1.5% levels separately during dough preparation to replace 20-40% hydrogenated vegetable fat. The optimum level of each fat replacer was selected on the basis of preliminary trails and sensory evaluation viz. carabeef cookies incorporated with 0.5% PSP to replacer 20% fat (PO), carabeef cookies incorporated with 1.5% GGP to replace 40% fat (GT) and carabeef cookies incorporated with 1.0% PPP to replace 30% fat (PL). Final experiment was conducted to evaluate the comparative efficacy of these fat replacers at their optimum level as selected in above three sub experiments. Here, C, PO1, PL2 and GT3 were evaluated for various physico-chemical properties, sensory attributes, textural parameters and color values to ultimately select one treatment as optimum level of fat replacer.

Physico-chemical properties

The physico-chemical properties of low fat 0 presented in Table 2. There was significant difference (P<0.05) among treatments for all physico-chemical properties except thickness of cookies. pH of PL was significantly lower (P<0.05) as compared to PO and GT, it could be due to comparatively lower pH of plum pulp (Ahmad et al., 2004), however pH values of GT and PO were comparable. Cooking yield of GT was significantly higher (P<0.05) as compared to PL and PO, which might be due to higher moisture retention capacity of starches. The proximate parameters like moisture, protein and ash percentage were significantly higher (P<0.05) in guar gum incorporated low fat carabeef cookies as compared to other two treatments. Murwan et al. (2012) evaluated the proximate composition of guar gum obtained from Guar (*Cyamopsis tetragonoloba*) and reported that it contained 4.8-8.7% moisture, 3.5-5.0% protein, 0.5-0.9% fat, 0.5-0.8% ash percentage and carbohydrate 83.3-87.5% respectively. There was significant difference (P<0.05) in fat percentage between treatments, the lowest fat percentage was observed in GT followed by PL>PO. Lower fat in GT and PL as compared to PO might be due to higher percentage of guar gum and plum pulp powder used in carabeef cookies as compared to poppy seeds powder. Another reason for this finding could be higher oil content in poppy seeds than guar gum and PPP. There was no significant difference in thickness of cookies, while diameter and spread ratio were significantly higher (P<0.05) in PO, there was no significant difference between PL and GT for diameter and spread ratio values. The possible reason for this might be higher percentage of guar gum and plum pulp powder used as fat replacers in carabeef cookies. As per Zoulias et al. (2000), fat replacement in baked products like biscuits could reduce spread ratio and increased thickness due to hardness effect of fat replacers.

Table 2: Physico-chemical properties of functional low fat carabeef cookies incorporated with different selected fat replacers (Mean±SE)

Parameters	PO	GT	PL
pH	5.71±0.02a	5.67±0.01ab	5.64±0.01b
Cooking yield (%)	81.88±0.09b	82.15±0.05a	82.08±0.03ab
Moisture (%)	2.35±0.03b	2.87±0.04a	2.36±0.03b
Protein (%)	41.95±0.34b	43.01±0.30a	42.28±0.18ab
Fat (%)	15.43±0.03a	12.02±0.02c	12.69±0.03b
Ash (%)	2.84±0.03b	2.94±0.01a	2.89±0.01ab
Thickness (mm)	1.09±0.003	1.09±0.019	1.10±0.004
Diameter (mm)	55.13±0.04a	54.90±0.03b	54.95±0.04b
Spread ratio	50.50±0.16a	49.31±0.27b	49.87±0.22b

Mean±SE with different superscripts in a row differ significantly (P<0.05); n=6

Instrumental textural parameters

The textural properties of low fat functional carabeef cookies are presented in Table 3 There was significant difference (P<0.05) in hardness and shear force values between control and treatments, while no significant difference was observed in adhesiveness of cookies. Mean hardness and shear force values were significantly lower (P<0.05) in PO, but values were comparable between GT and PT. The possible reason for these findings might be the incorporation of guar gum and PPP in cookies at higher level and more fat replacement as compared to PSP incorporated carabeef cookies. Rajiv et al. (2012) reported that fat replacement with flaxseed in cookies might produce harder products with higher

breaking strength. Jacob and Leelavathi (2007) studied the effect of four different fat replacers on texture quality of biscuits and reported that fat replacement had adverse effect on textural quality of biscuits with higher hardness and breaking strength.

Table 3: Instrumental textural parameters of functional carabeef cookies incorporated with different selected fat replacers

Parameters	PO1	GT3	PL2
Hardness (N/cm2)	5.64±0.09b	5.86±0.06a	5.85±0.06a
Shear force value (kg/cm2)	4.51±0.05b	4.81±0.06a	4.70±0.05ab
Adhesiveness (N/gm)	3.22±0.03	3.39±0.06	3.41±0.07

Mean±SE with different superscripts in a row differ significantly (P<0.05); n=6

Color values: There was a significant difference (P<0.05) in redness and hue angle, but yellowness and chroma values had no significant difference among low fat functional carabeef cookies (Table.4). The redness and hue angle values of PL were significantly higher (P<0.05) as compared to PO and GT due to dark red color of plum pulp powder however there was no significant difference between PO and GT. Jacob and Leelavathi (2007) prepared low fat biscuits with incorporation of four different fat replacers and observed no significant difference in redness and yellowness of biscuits incorporated with different fat replacers.

Table 4: Color values of functional carabeef cookies incorporated with different selected fat replacers

Parameters	PO1	GT3	PL2
Redness	4.28±0.08b	4.35±0.13b	4.95±0.14a
Yellowness	3.75±0.09	3.70±0.08	3.51±0.08
Chroma	5.69±0.12	5.71±0.13	6.07±0.11
Hue angle	0.83±0.01b	0.87±0.04b	1.16±0.06a

Mean±SE with different superscripts in a row differ significantly (P<0.05); n=6

Sensory evaluation: The sensory scores of low fat functional carabeef cookies are presented in Table 5. Color and appearance scores of PL were significantly lower (P<0.05) due to dark color of fruit, however no significant difference was observed between GT and PO. There was no significant difference in flavor, texture and after taste scores among treatments. The crispiness and overall acceptability scores were significantly higher (P<0.05) in GT than other treatments, but no significant difference was observed between PL and PO. Lower sensory scores of PO might be due to somewhat pungent mouth feel after swallowing of cookies as observed by sensory panellists. Jalal et al. (2014) also observed that low fat gostaba could be prepared with incorporation of sodium alginate with improved quality and sensory acceptance. Rather et al. (2017) reported higher acceptability of low fat emulsion incorporated with 1.0% guar gum as fat replacer in terms of higher overall acceptability scores. In present study, the highest overall acceptability scores were recorded in GT due to appealing color, crispiness and pleasant flavor of cookies.

Table 5: Sensory evaluation of functional carabeef cookies incorporated with different selected fat replacers (Mean±SE)

Parameters	PO	GT	PL
Color and appearance	7.18±0.07a	7.24±0.05a	6.89±0.05b
Flavor	7.00±0.06	7.16±0.05	7.18±0.04
Texture	6.89±0.14	6.94±0.12	6.85±0.10
Crispiness	7.07±0.08b	7.13±0.08a	7.04±0.06b
Aftertaste	7.01±0.06	7.12±0.05	7.19±0.07
Overall acceptability	6.84±0.05b	7.09±0.05a	6.86±0.04b

Mean±SE with different superscripts in a row differ significantly (P<0.05); n=21

CONCLUSION

The evaluation of carabeef cookies incorporated with optimum level of different fat replacers proved that quality attributes of product were not compromised; moreover functionality of carabeef cookies was enhanced in terms of lower fat percentage in product, which is the requirement of present day health conscious consumers. The sensory scores of various attributes including overall acceptability were most acceptable for GT as compared to PL and PO. Therefore, on the basis of various physico-chemical properties, instrumental textural properties, color values and sensory evaluation, 1.5% guar gum powder was selected as optimum level of fat replacer and carabeef cookies incorporated with 1.5% guar gum to replacer 40% hydrogenated vegetable fat (GT3) were selected as the best treatment.

COMPETING INTERESTS: The authors have no known competing interests either financial or personal between themselves and others that might bias the work.

ETHICS STATEMENT: Not Applicable

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