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Research Paper

Development and Quality Assessment of Mango Peel Powder Incorporated Functional Carabeef Cookies

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ABSTRACT

The present study was carried out to develop and assess the quality attributes of fiber enriched functional carabeeef cookies. The products were formulated with incorporation of mango peel powder (MPP) by replacing refined wheat flour as: Control (C) with no mango peel powder, MT1 (with 5% MPP), MT2 (with 10% MPP) and MT3 (with 15% MPP). There was a significant difference ($p<0.05$) in all physcio-chemical properties due to incorporation of MPP in carabeef cookies. The cooking yield and moisture content significantly increased ($p<0.05$), however, protein and ash content decreased significantly ($p<0.05$) at more than 10% level. Mean insoluble dietary fiber (IDF), soluble dietary fiber (SDF) and total dietary fiber (TDF) content increased significantly ($p<0.05$) with the incorporation of MPP in carabeef cookies. Spread ratio and thickness of cookies were comparable with control upto 10% level however, decreased significantly ($p<0.05$) at 15% of mango peel powder incorporation. The sensory scores for all attributes were comparable upto 10% level of MPP incorporation. The sensory scores decreased significantly ($p<0.05$) at 15% MPP level than control except for texture. Shear force value and adhesiveness were not affected upto 10% MPP incorporation, but decreased significantly ($p<0.05$) at 15% level. Color parameters like redness, yellowness, chroma and hue angles values were not significantly affected. Thus mango peel powder at 10% level was selected as optimum for incorporation in carabeef cookies as natural fiber source.

Keywords : *Carabeef cookies, Mango peel powder, Quality assessment, Functional foods*

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INTRODUCTION

Mango *(Mangifera indica L.)* belongs to family Anacardiaceae and is relished by a large section of society worldwide. The world production of mango fruits is more than 35 million tones, where around 20% of fruits are processed for products such as puree, nectar, pickles, canned slices etc. Mango peel is a major by product during processing of mango, which makes 15-20% of fruit. As peel is not currently utilized for any commercial purpose, it is declared as a waste and becoming a source of environmental pollution. Mango peel powder is good source of phytochemicals such as polyophenols, carotenoids, vitamin E, dietary fiber and vitamin C (Ashoush and Gadallah 2011). It also contains antioxidant, anticarcinogenic, antimutagenic and other health promoting properties (Block and Langseth 1994). Mango peel powder contains 10.5% moisture, 2.2% fat, 3.6% protein, 80.7% carbohydrate and 3.0% ash. The total dietary fiber content in MPP is 51.2%, in which insoluble dietary fiber (IDF) constitutes 32.1% and the soluble dietary fiber (SDF) content was 19.0% (Ajila *et al*. 2008). Therefore incorporation of mango peel powder in meat products may improve functionality and provide various health benefits.

Buffaloes in India contribute about 33% of total meat production with 111.3 million populations which is more than 58 per cent of the world's total buffalo population (APEDA 2010). Thus availability of buffalo meat is abundant and there is ample scope to utilize it for the development of value-added ready-to-eat snack meat products like meat cookies. Cookies are chemically leavened, ready to eat quick snacks with several attractive features including wider consumption base, relatively longer shelf-life, more convenience and good eating quality (Hooda and Jood 2005). Some of the reasons for such wide popularity are low and affordable cost as compared to other processed foods, good nutritional quality and availability in different forms, varied taste along with longer shelf-life. Buffalo meat contains high biological value protein and important micronutrients that are needed for good health throughout life. Buffalo meat is the healthiest meat among red meats known for human consumption because it is low in calories and cholesterol; however it contains more amounts of saturated fatty acids (Kandeepan *et al*. 2013). It is a challenging task for the meat technologists to develop shelf stable processed ready to eat meat products with higher nutritional values and functionality. Therefore, the present study was envisaged to develop highly nutritious fiber enriched carabeef cookies.

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MATERIALS AND METHODS

Retail cuts of freshly slaughtered buffalo (5-7 years old) was procured from meat shop and kept in refrigerator at 4±1^{0}C for 6-8 hours. The chilled cut was deboned and the boneless meat stored at -18^0 C till further use. The various ingredients such as refined wheat powder, vanaspati ghee (Dalda), milk powder, sugar, glucose, vanilla essence, baking powder and salt were purchased from the local market. The culture media and chemicals used in the study were procured from Hi Media Laboratories (P) Ltd, Mumbai and Merck Specialties Ltd, India. Low density Polyethylene (LDPE) bags of 60μ 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 16-18 hours at 50-60^{0}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 4-5% moisture, 77-78% protein, 11-13% fat and 4-5% 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 level in cookies and 50% carabeef powder incorporation replacing refined wheat flour was selected as optimum. Refined wheat flour, carabeef 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 150-160^{0}C for 35-40 minutes. The baked cookies were then cooled to room temperature and immediately packaged. Carabeef cookies incorporated with four different levels of mango peel fiber replacing refined wheat flour were abbreviated as: C-control carabeef cookies with no mango peel fiber, MT1-carabeef cookies with 5% mango peel fiber, MT2- carabeef cookies with 10% mango peel fiber and MT3- carabeef cookies with 15% mango peel fiber.

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 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).

RESULTS AND DISCUSSION

Physico-chemical properties: The physico-chemical properties of carabeef cookies incorporated with mango peel powder are presented in Table 2. ANOVA revealed a significant difference ($p<0.05$) in physcio-chemical properties with the incorporation of mango peel powder in carabeef cookies. There was significant decrease ($p<0.05$) in pH of treatments as compared to control due to lower pH of mango peel powder as compared to refined wheat flour. Jaiswal *et al*. (2013) observed significant ($p<0.05$) decrease in pH of chicken biscuits with increased level of meat. The cooking yield of product increased significantly ($p<0.05$) in MT2 and MT3 than C due to the presence of pectin in mango peel powder, however no significant difference was observed between C and MT1. As per Sudhakar and Maini (2000), mango peel is rich in pectin which is a soluble dietary fiber with higher water absorption capacity. Dikeman and Fahey (2006) also observed significantly higher cooking yield in mango peel powder incorporated refined wheat flour cookies than control due to interaction between water and hydroxyl groups of polysaccharides through hydrogen bonding. Further, Ashutosh and Gadallah (2011) observed addition of 10% mango peel powder increased water absorption for treatment dough and higher baking yield of cookies.

Table 1: Formulation of control and mango peel fiber incorporated carabeef cookies

Ingredients (%)	C	MT1	MT2	MT3
Carabeef powder	25	25	25	25
Refined wheat flour	25	20	15	10
Fiber source	-	5	10	15
Hydrogenated vegetable oil	17.5	17.5	17.5	17.5
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-control cookies with no mango peel fiber; MT1-carabeef cookies with 5% mango peel fiber; MT2- carabeef cookies with 10% mango peel fiber; MT3- carabeef cookies with 15% mango peel fiber

Table 2: Physico-chemical properties of carabeef cookies incorporated with mango peel fiber

Parameter	C	MT1	MT2	MT3	Treatment Mean
pH	5.94 ± 0.01^{a}	5.80 ± 0.01^{b}	5.69 ± 0.01^{c}	5.64 ± 0.01^{d}	5.77 ± 0.02
Cooking yield (%)	81.21 ± 0.28^{b}	81.32 ± 0.17^{b}	81.73 ± 0.15^{ab}	82.42 ± 0.19^{a}	81.67 ± 0.13
Thickness (mm)	1.08 ± 0.003^{ab}	1.09 ± 0.004^{a}	1.08 ± 0.003^{ab}	1.07 ± 0.004^{b}	1.08 ± 0.002
Diameter (mm)	55.31 ± 0.06^{a}	55.13 ± 0.04^{ab}	55.08 ± 0.04^{b}	50.00 ± 0.03^{b}	54.13 ± 0.03
Spread ratio	51.06 ± 0.19^{a}	51.09 ± 0.79^{a}	51.01 ± 0.16^{a}	50.85 ± 0.23^{b}	51.12 ± 0.20

Mean ± SE with different superscripts in a row differ significantly ($p<0.05$); n= 6 for each treatment

The diameter of carabeef cookies decreased significantly ($p<0.05$) at e"10% level, but no significant difference was observed between MT2 and MT3. Spread ratio was significantly lower ($p<0.05$) in MT3 than C, but there was no significant difference in spread ratio of cookies upto 10% incorporation of mango peel powder. The reduced values of physical parameters in MT3 might be due to dilution of gluten with reduced amount of refined wheat flour replaced with MPP (Rosell *et al*. 2001). These findings were in agreement with Ajila *et al*. (2008) and Ashoush and Gadallah (2011) who developed fiber enriched cookies by incorporation of mango peel powder replacing refined wheat flour at different levels.

Proximate analysis: The proximate parameters of carabeef cookies incorporated with mango peel powder are presented in Table.3. Mean moisture percentage increased significantly ($P<0.05$) in treatments as compared to control due to higher water absorption capacity of pectin (Sudhakar and Maini 2000). However, there was a significant decrease ($p<0.05$) in protein and ash percentage at higher level of mango peel powder, although fat percentage of control and treatments was comparable. Ahmad *et al.* (2014) also observed that moisture percent increased whereas protein percent decreased significantly ($p<0.05$) in restricted buffalo meat fillets extended with hydrated barley. The difference in proximate parameters of cookies might be explained by difference in proximate composition of mango peel powder (MPP) and refined wheat flour. MPP contained 3.60% protein, 1.23% fat and 3.88% ash percentage (Ashoush and Gadallah 2011) while Baljeet *et al*. (2014) reported 11.7% protein, 1.40% fat, 0. 7% ash and 74.1% carbohydrate in refined wheat flour. Mean IDF, SDF and TDF content increased significantly ($p<0.05$) with the incorporation of MPP in carabeef cookies, due to presence of pectin as fiber in mango peel. Mango peel powder contained 19.0% SDF, 32.1% IDF and 51.2 % total dietary fiber (Ajila *et al*. 2008). Thickness of cookies were comparable with control upto 10% level of mango peel powder, however it decreased significantly ($p<0.05$) in MT3.

Instrumental textural parameters: There was a significant difference ($p<0.05$) in shear force values and adhesiveness values as compared to C, although no significant difference

was observed in hardness of cookies with incorporation of mango peel powder (Table 4). There was an increasing trend in shear force values with increase in MPP incorporation. These were not significantly different among C, MT1 and MT2, but decreased significantly ($p<0.05$) in MT3. Mean adhesiveness value was significantly higher ($p<0.05$) in MT3 as compared to control, however values were comparable upto 10% level of incorporation of fiber. Gluten proteins present in refined wheat flour is basically responsible for textural characteristics of cookies (Rai *et al*. 2014), so replacement of refined wheat flour with fiber sources might be prominent reason to decrease gluten content in cookies and provided harder texture to cookies. Chevallier *et al*. (2000) also observed harder texture of cookies with higher protein content due to no aggregation and hydration of large sized protein particles to form gluten network. Kulkarni and Joshi (2013) and Norhidayah *et al*. (2014) also observed harder biscuits during preparation of fiber enriched biscuits prepared by incorporation of pumpkin powder and banana flour, respectively.

Color values: There was no significant difference in redness, yellowness, chroma and hue angles values between control and treatments (Table 5). It might be due to leaching of myoglobin during partial steam cooking of buffalo meat, however dark color of treatments as compared to control might be due to dark brown color of mango peel powder. The redness of cookies increased slightly with decrease in yellowness due to increased level of mango peel powder. Similar findings were also observed by Ashoush and Gdallah (2011) in cookies prepared by incorporation of mango peel powder and kernel powder. The polyphenol oxidase and peroxidase activities on polyphenols substrates present in mango peel are responsible for enzymatic browning and darkening of snacks products (Saby *et al*. 2003).

Sensory evaluation: The Table 6 indicates significant ($p<0.05$) decrease for all sensory attributes in MT3 as compared to C except for texture. The sensory scores for all attributes were comparable upto 10% level of mango peel powder incorporation in cookies. Mean color and appearance scores decreased significantly ($p<0.05$) in MT3, these were comparable amongst C, MT1 and MT2. Azizh and Komathi (2009) reported that mango peel flour imparted a dark brown color to crackers and affected the liking of sensory panelists at higher percentage. There was no significant difference in flavor of cookies among C, MT1 and MT2, but flavor scores were slightly higher in MT2, which could be due to mango flavor perceived in cookies by sensory panelists. Flavor scores of MT3 were significantly ($p<0.05$) lower than control and other treatments, which might be due to slightly bitter taste because of higher polyphenolic content at such a higher level. Similar findings were also observed by Ashoush and Gadallah (2011) in cookies at more than 15% mango peel powder incorporation as fiber source. There was no significant difference observed in texture scores of control and treatments. The crispiness and after taste scores in MT3 decreased significantly ($p<0.05$), although scores were comparable upto 10% of mango peel powder incorporation. The sensory panelists recorded comparatively more hardness in cookies with MPP incorporation at higher level due to relatively higher water content in MPP incorporated doughs. As per Smith (1972) and Gaines (1990), dough having higher water content produced an extensive gluten structure and resulted in harder biscuits. Overall acceptability scores decreased significantly ($p<0.05$) in MT3, however scores were comparable upto 10% level of fiber incorporation with control. There was no significant difference between MT1 and MT2, however among all three treatments the highest overall acceptability scores were obtained for MT2 with 10% mango peel powder. These findings were in agreement with Azizh and Komathi (2009) and Ashoush and Gadallah (2011) who indicated that very well accepted functional cookies could be prepared by incorporating MPP upto 10% level.

Table 3: Proximate analysis of carabeef cookies incorporated with mango peel fiber

Parameters (%)	C	MT1	MT2	MT3
Moisture	2.00 ± 0.03^{c}	2.11 ± 0.04^{bc}	2.26 ± 0.02^{b}	2.39 ± 0.03^{a}
Protein	42.28 ± 0.30^{a}	41.33 ± 0.20^{ab}	41.46 ± 0.25^{b}	40.73 ± 0.10^{b}
Fat	19.82 ± 0.20	19.74 ± 0.08	19.46 ± 0.14	19.35 ± 0.07
Ash	2.89 ± 0.01^{a}	2.88 ± 0.01^{a}	2.79 ± 0.01^{b}	2.78 ± 0.01^{b}
IDF	0.77 ± 0.03^{d}	2.47 ± 0.08^{c}	4.03 ± 0.12^{b}	5.15 ± 0.16^{a}
SDF	0.45 ± 0.27^{d}	0.86 ± 0.05^{c}	1.32 ± 0.10^{b}	2.74 ± 0.14^{a}
TDF	1.23 ± 0.04^{a}	3.33 ± 0.10^{c}	5.35 ± 0.15^{b}	7.89 ± 0.17^{a}

Mean ± SE with different superscripts in a row differ significantly ($p<0.05$); n= 6 for each treatment

Table 4: Instrumental textural parameters of carabeef cookies incorporated with mango peel fiber

Parameters	C	MT1	MT2	MT3
Hardness (N/cm^2)	5.96±0.36	6.06±0.29	5.96±0.17	6.48±0.22
Shear force value (kg/cm^2)	3.98±0.04^b	4.00±0.03^b	4.29±0.18^b	4.69±0.05^a
Adhesiveness (N/gm)	3.27±0.05^b	3.36±0.08^{ab}	3.43±0.06^{ab}	3.49±0.07^a

Mean ± SE with different superscripts in a row differ significantly ($p<0.05$); n= 6 for each treatment

Table 5: Color values of carabeef cookies incorporated with mango peel fiber

Parameters	C	MT1	MT2	MT3
Redness	4.38±0.12	4.46±0.05	4.50±0.08	4.48±0.17
Yellowness	3.75±0.09	3.68±0.08	3.65±0.07	3.61±0.10
Chroma	5.76±0.15	5.79±0.09	5.79±0.05	5.76±0.13
Hue angle	0.86±0.02	0.92±0.02	0.95±0.05	0.96±0.08

n= 6 for each treatment

Table 6: Sensory attributes of carabeef cookies incorporated with mango peel fiber

Parameters	C	MT1	MT2	MT3
Color and appearance	7.11±0.09^a	7.02±0.05^a	6.90±0.06^{ab}	6.69±0.06^b
Flavor	7.12±0.06^a	7.13±0.05^a	7.25±0.06^a	6.73±0.06^b
Texture	7.00±0.13	6.91±0.12	6.87±0.11	6.64±0.11
Crispiness	7.18±0.10^a	7.10±0.08^{ab}	7.07±0.08^{ab}	6.85±0.08^b
Aftertaste	7.17±0.08^a	7.08±0.09^{ab}	7.05±0.10^{ab}	6.75±0.10^b
Overall acceptability	7.08±0.08^a	6.94±0.07^{ab}	6.95±0.07^{ab}	6.67±0.07^b

Mean ± SE with different superscripts in a row differ significantly ($p<0.05$); n= 21 for each treatment

CONCLUSION

The incorporation of mango peel fiber enhanced cooking yield and total dietary fiber content in carabeef cookies without any adverse effect on color, texture and sensory attributes upto 10% level. Therefore 10% mango peel fiber incorporation in carabeef cookies was adopted as optimum and used in further studies to improve functionality of product.

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