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Enhancement of Storage Stability, Textural Profile, Physico-Chemical Parameters and Sensory Attributes of Chevon Meatballs by Guava Powder Incorporation

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Abstract

Guava (Psidium *guajava*) powder was added to chevon meatball mixture at the rate of 1.0%, 1.5% and 2.0% on w/w basis to evaluate the storage stability, textural parameters, physico-chemical properties of cooked chevon meatballs. The products were stored for a period of 21 days at refrigeration temperature (4±1 °C). Studies indicative of storage stability were conducted on 0, 3, 7, 14 and 21 day rest all studies were conducted on day zero. Six sets of experiments were conducted and each experiment had been replicated four times i.e. n=24. During the 21 days refrigerated storage period, compared to control samples, the guava powder treated samples had significantly lowered (p<0.05) thiobarbituric acid reacting substances values and lower total plate count, total psychrotrophic count, total coliform count and yeast and mould count, thus indicating improved anti-oxidant and microbiological quality. Addition of guava powder to the meatball mixture had significantly reduced (p<0.05) the emulsion stability of the meatball mixture. The final product had significantly (p<0.05) lowered moisture, fat, ash, moisture retention, fat retention and pH. The cooking yield too was significantly reduced (p<0.05) but the meatballs produced had desirable textural properties, improved sensorial characteristics and better acceptability. This study indicated that guava powder could successfully be utilized as additives to meatball mixtures to to produce meatballs having improved shelf-life and and superior functional properties.

Keywords: Chevon meatball, guava powder, natural anti-oxidant, anti-microbial

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1. Introduction

Goat meat has been an ideal choice of red meat among the health conscious population but if not stored properly, its high moisture and rich nutrient content makes it prone to microbial spoilage and lipid oxidation. At the time of processing meat undergoes a number of alterations, physical alterations like chopping, grinding and mincing, chemical alterations like marination (storage under controlled environment) and heat treatment (ex. frying, baking etc.). All such activities results in the development of oxygenated free radicals which in turn initiate the oxidation of polyunsaturated fatty acids resulting in deterioration of color, texture and nutritive value and development of off odours (Kanner, 1994). Moreover physical activities like handling, manual processing and improper and inconsistent storage conditions

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lead to increase in the microbial load of the final product. The most common method of food preservation is chemical preservation but prolonged consumption of such chemicals may cause significant health hazard. In the present scenario the current trend of food preservation has shifted toward natural antioxidants and antimicrobials derived from various plant materials which are rich in radical-scavenging polyphenols and antimicrobial compounds (Shahidi et al., 1992). The peel and flesh of guava (*Psidium guajava*) is rich in dietary fibre and vitamin C attributing to its high antioxidant capacity. It contains high levels of dietary fiber associated with natural anti-oxidant components, indigestible fraction, bioactive compounds viz. flavonoids, carotenoids, terpenoids and triterpenes and phenolic compounds viz. myricetin, apigenin, ellagic acid, and anthocyanins (Misra and Seshadri, 1968; Jime´nez-Escrig et al., 2001 and Miean et al., 2001). Guava is also known to posses anti-microbial properties. The fruit is used for the treatment of anorexia, cerebral ailments, cholera, convulsions, epilepsy, nephritis and jaundice (Kamath et al., 2008). It has been discovered that Ethanolic extract of the ripe fruit helps in preventing activity on *Streptococcus mutans* and *Escherichia coli* (Neira and Ramirez, 2005). Meatballs are an extremely popular delicacy and these are a processed from comminuted meat. Due to its meat form and processing technique they have short storage life. Guava powder (GP) was incorporated in the meatball mixture and meatballs were prepared by steam cooking. The effect of GP on the storage stability of the cooked product under refrigerated (4±1 °C) temperature was evaluated along with physico-chemical characteristics, textural properties and sensory parameters.

2. Materials and Methods

The study was carried from November 2017 to February 2019. Medium ripe guava were purchased from local market. The fruits were washed, cleaned and dried. Thin transverse slices were cut and these were dried in a hot air oven at 47±2 °C for 24 hrs. The dehydrated guava slices were ground to a fine powder and sieved. These samples were then aerobically packed in UV sterilized Low Density Polyethylene (LDPE) containers and stored at -18±1 °C until further utilization. Meatballs were prepared according to the methodology as described by Kumar (2001) with slight modification. The ingredients required were procured from the local market. For this purpose lean chevon was used as was minced as mentioned a in two steps, firstly by using 10mm plate and then by 5 mm plate. For the dry spice mix all the ingredients were first dried in a hot air oven at 50 °C for 4 hrs and ground into a fine powder. The condiment mixture was prepared by blending peeled and sliced onion, ginger and garlic in the ratio 3:1:1 in a grinder till it became a smooth paste. All the chemical incorporated in the formulation were of food grade quality. Minced chevon was mixed with other ingredients and four batches of meatballs were prepared namely, control batch (CM), treatment 1(M1), treatment 2 (M2) and treatment 3 (M3) as represented in Table 1. Meatballs were manually prepared from 25 g of the meatball mixture using a metal shaper (Serdaroglu and Degırmencioglu, 2004). The raw meatball had both diameter and thickness of 3.5 cms. These meatballs were then steam cooked in metal containers at 6.8 kg pressure and 121 °C temperature for 20 min. (Kumar et al., 2013). The anti-oxidant effect of guava powder (GP) on cooked meatballs was analyzed by estimating the Thiobarbituric Acid Reacting Substances (TBRAS) values (Tarladgis et al., 1960) whereas the anti-microbial ability was determined by estimating Total Plate Count (TPC), Total Psychrotrophic Count (TPSC), Total Coliform Count (TCC) and Yeast and Mould Count (YMC) (APHA, 2001). These studies were conducted on day 0, 3, 7, 14 and 21 of refrigerated (4±1 °C) storage . For all the microbiological analysis readymade media from Hi-Media Laboratories ℗ Ltd., Mumbai, were used. Physico-chemical parameters, texture profile analysis and sensory evaluation were conducted only for day zero. The proximate paramètres were determined by methods described by AOAC (2001). For pH determination sample preparation was done according to Troutt et al., 1992 and was recorded using a digital pH meter. Standard equations were applied to determine the % moisture retention (El-Magoli et al., 1996), % fat retention, % cooking yield (Murphy et al., 1975) and % shrinkage (Adams, 1994) of the cooked meatball and emulsion stability of the meatball mixture was determined by procedure established by Kondaiah et al. (1985). Textural property of the meatball was analyzed by TA-HDi Texture Analyzer (Stable Micro Systems,UK) using procedure described by Bourne (1978). For sensory evaluation the steam cooked meatballs were deep fried in rice bran oil till they attained an internal temperature of 65 ˚C and the desired brown color developed. These fried meatballs were presented to a

Table 1: Formulation of chevon meatballs

Ingredients (%)	CM	M1	M2	M3
Minced lean chevon	70%	69%	68.5%	68.0%
Rice bran oil	7.0%	7.0%	7.0%	7.0%
Ice Flakes	8.70%	8.70%	8.70%	8.70%
Salt	1.6%	1.6%	1.6%	1.6%
Tripolyphosphate	0.3%	0.3%	0.3%	0.3%
Sugar	0.3%	0.3%	0.3%	0.3%
Dry spice powder	1.8%	1.8%	1.8%	1.8%
Condiment mixture	4.0%	4.0%	4.0%	4.0%
Refined wheat flour	3.0%	3.0%	3.0%	3.0%
Egg albumin	1.285%	1.285%	1.285%	1.285%
Sodium nitrite	0.015%	0.015%	0.015%	0.015%
Guava powder	0%	1.0%	1.5%	2.0%

sensory panel consisting of seven judges. A 8 point hedonic scale was adopted indicating 8 as extremely desirable and 1 as unacceptable. For this study six sets of experiments were conducted and each experiment had been replicated four times making n=24. All data obtained during this investigation were analyzed statistically by using SPSS-24® software package. For storage studies, data were analysed using two-way ANOVA with interaction taking treatment and storage time as main effects. For physics-chemical parametres and texture profile analysis one-way ANOVA was used. To compare means, Duncan's multiple range test (Duncan, 1955) was adopted. For analysis of data related to different criteria of sensory evaluation The Kruskal-Wallis H test (Kruskal and Wallis, 1952) was adopted. A probability value of $p<0.05$ was described as significant.

3. Results and Discussion

The effect of GP on lipid oxidation rate in raw minced meat as well as cooked meatball stored at refrigerated (4±1 °C) temperature are indicated in Table 2. All values recorded were statistically significant ($p<0.05$) and these values increased significantly ($p<0.05$) with each passing day. A trend indicating decrease in TBA values with increase in percentage GP incorporation was observed. Control batches indicated an initial TBA value of 0.322 mg mda kg^{-1} and it reached a concentration of 1.325 mg mda kg^{-1} on 21st day of refrigerated storage. Addition of GP had significant ($p<0.05$) effect on the initial values of TBA. Addition of GP at 1%, 1.5% and 2.0% to the meatball mixture resulted in reduction in TBA values by 8.23%, 13.36% and 21.43%, when noted on 21st day of refrigerated storage. In a study conducted by Verma et al. (2013) guava powder was incorporated in sheep meet nuggets at the rate of 0.5% and 1.0%. They had indicated 37% reduction in TBARS number than the control samples on day 15 of storage, a result coherent to the observations of this study which indicated 36.48% reduction in TBARS values than the control samples on 14th day of storage. Similar observations were made by Devatkal et al. (2010) who added kinnow rind, pomegranate rind and seed powder to goat meat patties; Banerjee et al. (2012) who added broccoli powder to goat meat nuggets and Das et al. (2014) who added bale pulp extract to goat meat nuggets. The peel and pulp of guava fruit contains high levels of vitamin C, dietary fiber and phenolic compounds (Jime´nez-Escrig et al., 2001). All these components are associated with reduction in lipid-peroxidation rate and free radical formation, thus enhancing the shelf-life of the chevon meatballs.

Table 2: Anti-oxidant potential of guava powder in cooked chevon meatballs (mean±S.E.)

Treat-ment	TBARS values (mg mda kg^{-1})				
	Storage days				
	Day 0	Day 3	Day 7	Day 14	Day 21
CM	0.322±0.017^{eA}	0.509±0.017^{dA}	0.647±0.013^{cA}	1.058±0.015^{bA}	1.325±0.019^{aA}
M1	0.31±0.015^{eC}	0.466±0.016^{dB}	0.555±0.017^{cB}	0.714±0.018^{bB}	1.216±0.02^{aB}
M2	0.315±0.014^{eB}	0.431±0.017^{dC}	0.516±0.014^{cC}	0.672±0.016^{bC}	1.148±0.013^{aC}
M3	0.315±0.017^{eB}	0.38±0.016^{dD}	0.507±0.014^{cD}	0.625±0.017^{bD}	1.041±0.017^{aD}

n=24; All treatment groups were under refrigerated storage (4±1 °C); CM: control chevon meatball; M1: 1.0% GP treatment; M2: 1.5% GP treatment; M3: 2.0% GP treatment Data (mean±SE) with different small letter superscripts in the same row differ significantly ($p<0.05$); Data (mean±SE) with different capital letter superscripts in the same column differ significantly ($p<0.05$)

Effect of GP on the microbial load of cooked pork meat balls stored at refrigerated temperature of (4±1) °C is presented in Table 3. Values relating TPC, TPSC, TCC and YMC were recorded on 0, 3, 7, 14 and 21 of storage. As stated by Jay (1992) spoilage in meat becomes evident when the surface microbial count reaches 7 log$_{10}$ cfu/g. Over the span of 21 days of refrigerated storage, compared to control samples it was observed that addition of GP to meatball mixture resulted in significant ($p<0.05$) reduction in TPC, TPSC, TCC and YMC values. GP was found to exhibit the capacity of inhibiting coliform growth till 14 days and yeast and mould growth till 7 days of refrigerated storage. Neira and Ramirez (2005) has reported ethanolic extract from the shell of ripe guava fruit helps in preventing activity on *Streptococcus* mutans and *Escherichia coli* . Moreover as tested, GP has a pH of 4.35 and addition of GP to the meatball mixture results in lowering of the pH of the cooked meatballs.Both these factors combined improved the microbial quality of the refrigerated product by prolonging the lag phase and retarding the log phase of microbial multiplication. The effect of GP on the physico-chemical property of the final product are illustrated in Table 4. All the values were recorded on the day of production and were statistically significant ($p<0.05$). It was observed that the percentage moisture, protein, fat, moisture retention, cooking yield and pH reduced with increase in GP concentration, vive-versa was observed for percentage ash and factors like percentage shrinkage and emulsion stability did not indicate any trend. Compared to control samples proximate analysis revealed significant reduction ($p<0.05$) in moisture and fat percentages in the treated product but no significant difference ($p>0.05$) was observed for moisture percentage between control and 1.0% GP treatment and 1.0% and 1.5% GP treatment. For protein no significant difference ($p>0.05$) was observed between control, 1.0% and 1.5% GP treatment and 1.5% and 2.0% GP treatment. Similarly no significant difference ($p>0.05$) was observed between control and 2.0% GP treatment for percentage shrinkage

Table 3: Effect of addition of guava powder on the microbiological parameters of cooked chevon meatballs stored at refrigerated (4+1 °C) temperature (mean±S.E.)

Treatment	Storage Days				
	Day 0	Day 3	Day7	Day 14	Day 21
Total plate count (TPC) of cooked chevon meatballs					
CM	3.544+0.027^{eB}	3.949±0.022^{dA}	4.45±0.024^{cA}	4.85±0.027^{bA}	5.344±0.025^{aA}
M1	3.639±0.022^{eA}	3.755±0.026^{dB}	4.145±0.026^{cB}	4.751±0.025^{bB}	5.251±0.026^{aB}
M2	3.548±0.026^{eB}	3.747±0.025^{dB}	3.954±0.024^{cC}	4.647±0.027^{bC}	4.95±0.025^{aC}
M3	3.542±0.028^{eB}	3.74±0.026^{dB}	3.845±0.026^{cD}	4.351±0.027^{bD}	4.851±0.022^{aD}
Total psychrotopic count (TPSC) of cooked chevon meatballs					
CM	1.148±0.026^{eA}	2.451±0.03^{dA}	3.947±0.024^{cA}	4.446±0.028^{bA}	5.147±0.025^{aA}
M1	N.D.	1.151±0.024^{dB}	2.348±0.027^{cB}	3.647±0.023^{bB}	4.548±0.026^{aB}
M2	N.D.	0.945±0.026^{dC}	1.749±0.028^{cC}	2.849±0.027^{bC}	3.445±0.026^{aC}
M3	N.D	0.85±0.027^{dD}	1.551±0.029^{cD}	2.25±0.029^{bD}	3.249±0.028^{aD}
Total coliform count (TCC) of cooked chevon meatballs					
CM	N.D.	N.D.	N.D.	1.549±0.029^{bA}	1.856±0.027^{aA}
M1	N.D.	N.D.	N.D.	N.D.	1.568±0.021^{aB}
M2	N.D.	N.D.	N.D.	N.D.	1.552±0.022^{aB}
M3	N.D.	N.D.	N.D.	N.D.	1.516±0.013^{aC}
Yeast and mould count (YMC) of cooked chevon meatballs					
CM	N.D.	N.D.	1.157±0.024^{cA}	1.646 ±0.027^{bA}	1.848 ±0.026^{aA}
M1	N.D.	N.D.	N.D.	1.365±0.023^{bB}	1.562±0.025^{aB}
M2	N.D.	N.D.	N.D.	1.358±0.016^{bC}	1.561 ±0.016^{aB}
M3	N.D.	N.D.	N.D.	1.325±0.0147^{bD}	1.53 ±0.015^{aC}

n=24; All values are expressed with the unit log10 cfu g^{-1}; ND: not detected; CM: Control chevon meatball; M1: 1.0% GP treatment; M2: 1.5% GP treatment; M3: 2.0% GP treatment; Data (mean±SE) with different small letter superscripts in the same row differ significantly (p<0.05); Data (mean±SE) with different capital letter superscripts in the same column differ significantly (p<0.05)

Table 4: Effect of addition of guava powder on the physico-chemical parameters of cooked chevon meatballs (mean±S.E.)

Treat-ment	Moisture %	Protein %	Fat %	Ash %	pH	% Moisture Retention	% Fat retention	% Cooking yield	Shrinkage %	Emulsion Stability
CM	63.016± 0.658^{a}	16.202± 0.0189^{a}	12.238± 0.650^{a}	2.141 ± 0.114^{d}	6.517± 0.054^{a}	61.002± 0.699^{a}	89.463± 0.119^{a}	96.828± 0.311^{a}	3.282± 0.104^{c}	95.54± 0.141^{a}
M1	62.464± 0.483^{ab}	16.053± 0.007^{a}	11.376± 0.159^{b}	2.428 ± 0.107^{c}	6.424± 0.033^{b}	59.503± 0.506^{b}	79.74± 0.411^{d}	95.316± 0.321^{b}	4.811± 0.219^{a}	94.782± 0.368^{b}
M2	61.908± 0.540^{b}	16.007± 0.007^{ab}	10.426± 0.155^{c}	2.733 ± 0.015^{b}	5.814± 0.013^{c}	58.519± 0.578^{c}	81.722± 0.441^{c}	94.547± 0.203^{c}	4.681 ± 0.151^{b}	92.546± 0.329^{c}
M3	61.145± 0.213^{c}	15.911± 0.02^{b}	9.749 ± 0.049^{d}	2.965 ± 0.032^{a}	5.619± 0.061^{d}	57.631± 0.218^{d}	87.058± 0.176^{b}	93.666± 0.544^{d}	3.283± 0.199^{c}	95.591± 0.371^{a}

n=24; Data (mean ± SE) with different small letter superscripts in the same column differ significantly (p<0.05)

and emulsion stability. Similar observations were made by Verma et al. (2013) and Banerjee et al. (2012) who added guava powder and broccoli powder to mutton and chevon nuggets, respectively. Such an outcome was observed due to the composition of meatball mixture where the proportion of meat gradually reduced with rise in GP concentration, moreover acidic nature of the GP resulted in a meat ball mixture of lower pH which resulted in higher fat loss and poor moisture retention in the final product, ultimately leading to a poorer cooking yield. Values displayed in Table 5 revealed effect of SFP on textural parameters of cooked meatball. All the values were recorded on the day of production and were statistically significant (p<0.05). It was observed that for hardiness, cohesiveness, gumminess and chewiness the control meatballs had the highest values but 1.5% GP treated meatballs had the highest springiness values. The hardiness values significantly reduced (p<0.05) with increase in percentage GP incorporation rest of the factors did not indicate such correlation. Hardiness of the meatball reduced because higher is the percentage incorporation of GP lower is the pH of the meatball mixture. Lower pH resulted in higher protein denaturation thus reducing the strength of the protein gel matrix resulting in poorer hardiness. Compared to control, the springiness values increased because with GP incorporation fat retention ability of the product reduced. Decrease in the amount of lean meat percentage in treated groups resulted in poorer gel matrix stability thus the control group had higher cohesiveness, gumminess and chewiness values. These observations were similar to the observation made by Huda et al. (2014) who added apple pomace to sheep meat nuggets but for Verma et al. (2013) addition of GP to sheep meat nuggets resulted in a product having lower hardness springiness, gumminess and chewiness but higher cohesiveness.

Table 5: Effect of addition of guava powder on the Texture Profile Analysis parameters of cooked chevon meatballs (mean±S.E.)

Treatment	Hardiness (N/cm^2)	Springiness (cm)	Cohesiveness	Gumminess (N/cm^2)	Chewiness (N/cm)
CM	60.294±0.002^a	0.707±0.002^d	0.325±0.003^a	15.204±0.002^a	12.013±0.002^a
M1	47.216±0.002^b	0.727±0.002^b	0.292±0.002^c	10.874±0.003^d	9.243±0.001^c
M2	46.223±0.003^c	0.734±0.003^a	0.295±0.001^b	11.283±0.004^c	10.216±0.002^b
M3	45.216±0.002^d	0.715±0.002^c	0.239±0.003^d	12.014±0.002^b	8.204±0.002^d

n=24; Data (mean±SE) with different small letter superscripts in the same column differ significantly (p<0.05)

As depicted in Table 6 it was noted that addition of GP had a significant effect (p<0.05) on sensory parameters but no particular trend was observed. It was observed that treatment with 2.0% GP resulted in a product with maximum flavour and overall acceptability. The control batch had the most impressive colour, outer texture, odour, tenderness and juiciness. No significant difference (p>0.05) was observed between CM, M1 and M2 for colour; M1 and M2 for odour, M1, M2 and M3 for flavour; CM and M2 for tenderness and CM and M1 for juiciness. Similar trend was observed for outer texture, juiciness and overall acceptability for sheep meat nuggets treated with guava powder (Verma et al., 2013) and goat meat nuggets treated with brocolli powder (Banerjee et al., 2012).

Table 6: Effect of addition of guava powder on the sensory evaluation parameters of cooked chevon meatballs on day zero (mean±S.E.)

Treatment	Colour	Outer texture	Odour	Flavour	Tenderness	Juciness	Overall accepatability
CM	6.729±0.466^a	6.583±0.803^a	6.667±0.789^a	6.708±0.806^b	6.688±0.749^a	6.667±0.643^a	6.271±0.908^d
M1	6.729±0.642^a	6.292±0.706^b	6.542±0.751^b	6.875±0.741^a	6.5±0.692^b	6.667±0.843^a	6.521±0.667^c
M2	6.75± 0.766^a	6.083±0.702^c	6.5±0.808^b	6.792±0.706^a	6.646±0.714^a	6.542±0.988^b	6.688±0.87^b
M3	6.438±0.577^b	5.854±0.616^d	6.354±0.634^c	6.792±0.674^a	6.271±0.551^c	6.396±0.722^c	6.875±0.784^a

n=24; Data (mean±SE) with different small letter superscripts in the same column differ significantly (p<0.05)

4. Conclusion

Shelf life of cooked chevon meatballs can be enhanced by addition of guava powder to the meatball mixture and best results had been observed for 2.0% treatment of meatball mixture. Guava powder addition produced chevon meatballs having better acceptability as well as improved functional properties.

5. Further Research

Other than choosing higher levels of GP incorporation the effect of different cooking techniques may be considered. The effect of vacuum and modified atmospheric packaging on the anti-oxidant and anti-microbial properties of GP on chevon meatballs could also be studied. Lastly analysis of the cost-effectiveness for commercialization of the developed product.

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