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# Effect of Green Banana Pulp Powder on Microbiological Quality of Chevon Nuggets During Refrigerated Storage

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## ABSTRACT

Functional meat products are often created by reformulating meat and adding health promoting ingredients such as fibres, prebiotics, probiotics, polyunsaturated fatty acids and antioxidants. Present research was undertaken to study the effect on incorporation of 4% green banana pulp powder on physico-chemical, microbiological and sensory characteristics of chevon nuggets stored at refrigeration temperature (4±1˚C) in low density polyethylene (LDPE) pouches up to 16 day. During storage, the product pH, thiobarbituric acid value and tyrosine values increased significantly ($p \leq 0.05$). The microbial quality parameters such as the total plate count increased throughout the storage period up to 16$^{th}$ days but were within the permissible limits. However, psychrophilic count was not detectable at 0 day but increased from 4$^{th}$ day to 16$^{th}$ day of storage. Sensory scores for all the characteristics declined progressively with the advancement of storage period up to 16$^{th}$ day. From this study, it can be concluded that chevon nuggets incorporated with 4% green banana pulp powder was very much acceptable up to 16$^{th}$ day of refrigerated storage.

***Key words:*** Chevon, Nuggets, Green banana powder, Physico-chemical, Microbiological and Sensory quality

# INTRODUCTION

Worldwide the livestock sector is highly dynamic and in developing countries, there is rapid increase in the demand of livestock products (Thornton, 2010). Meat is a valuable food and a crucial supply of protein. In India, only about 15gm of meat per person per day is available, compared to the ICMR,s recommended of 30gm. (Islam *et al.,* 2016). Goat meat is one amongst the foremost consumed red meats worldwide and through previous few years respectable increase in consumption of chevon (Madruga and Bressan, 2011). The increase in demand was chiefly because of the expansion of ethnic populations and additionally the notice of health-conscious shoppers of lower fat in chevon

compared to different red meats. Asian country distributes frozen and recent chilled meat (Guleria *et al*., 2015) especially in developing countries. In India, goat meat (chevon) is right on top of mutton (Sen *et al*., 2004). In developing countries, because of fast globalisation, urbanization and industrialisation, the people like fast foods which incorporates sort of meat product viz, cured meats patties, nuggets, meat balls (Aminzare *et al*., 2016).

Nugget prepared from chicken, chevon and cara beef or together with incorporation of vegetable protein, gum and is widespread selection of buyer. The acceptance of emptor for meat nuggets mainly depends upon sure factors like their taste, nutrition, price, suitableness, protein quality and the constancy of product. The superiority of nuggets will be significantly tormented by process, staple and ingredient factors. Fat content plays a crucial role in product options like flavour, appetisingness and texture similarly as technological properties. Currently consumers concern about the relation between diet and health and demand low fat and fibre enriched product.

Dietary pointers additionally advise a diet wealthy in fruit and vegetables for a healthy life vogue. World Health Organization (WHO) and worldwide health authorities like U.S Department of Agriculture (USDA) promote a high consumption of various fruit and vegetables. Natural dietary fibres sources are wonderful meat substitutes because of their inherent useful and nutritionary effects (Hur *et al*., 2009). Fibre intake through meat substituted with fruits, vegetables and grains is related to reductions in plasma and LDL-cholesterol, scale back the chance of major dietary issues like blubber, coronary diseases, diabetes, epithelial duct disorders, together with constipation, inflammatory internal organ diseases (Schneeman, 1999). Dehydrated fruit, vegetable and cereal fibre may be utilized in the food business as purposeful ingredient with wonderful results (Viuda *et al*., 2010) and intake of fibre reduces the danger and promotes a health (Kritchevsky, 2000). Banana is a part of human diet for several years and is that the second most vital fruit crop in Asian country next to mango (Abano, 2010). Green banana flour (GBF) contain 9.37% fibre (Pacheco-Delahaye *et al*., 2008). The degree of intermolecular bonding affects the ability of banana flours to absorb water, swelling power and solubility and are temperature-dependent due to the heat treatment's depolymerization of the starch molecule (Alexander, 1995). At initial pasting temperature of 63°C, the banana flour begins to gel which is useful for formation of emulsion based meat products. The effective antioxidants, flavonoids and phenolics, as well as vitamins C and A, glutathione, and flavonoids, are also abundant in GBF (Suntharalingam and Ravindran 1993).

There is very less data available on the effect of green banana pulp powder on chevon nuggets. Therefore, the objective of this research was designed to investigate the effects of green banana pulp powder on the physico-chemical quality, sensory property and microbial quality of chevon nuggets during refrigerated storage.

# MATERIALS AND METHODS

## A. Raw materials and sources:

### *i. Goat meat*

The goat meat was obtained from both hind legs of carcass of good confirmation from non-descriptive adult male goat slaughtered by traditional halal method from local market and the body fat, tendons and separable connective tissues were trimmed off. The dressed meat was packed in High density polyethylene pouches and kept in a refrigerator for 12 hrs at -18±1˚C which was thawed then subsequently used for product preparation.

### *ii. Common salt and vegetable oil*

Food grade common salt and refined vegetable sunflower oil required for formulation of chevon nuggets were purchased from local market of Udgir-city.

### *iii. Chemicals*

All the chemicals of analytical grade were procured from standard firms.

### *iv. Spice mixture*

Spice ingredients viz., black cardamom (Badielaichi), cinnamon (Dalchini), turmeric (Haldi), cloves (Laung), red chilli, coriander powder (Dhania), cumin seeds (Zeera), black pepper (Kali mirch), aniseed (Soanf) were purchased from the local market. All the spice ingredients were cleaned to remove extraneous matter and dried in oven at 60˚C for overnight and then ground to powder in a grinder. The coarse particles were removed using the sieve and the fine powder of the individual spices were mixed in a required proportion to obtain spice mix which was stored in airtight plastic container for subsequent use. The powdered mixture with required proportion of each ingredient Verma and Banerjee (2010) with slight modification was used for preparation of chevon nuggets (Table 1).

**Table 1.** Composition of spice mixture

| Sr. No | Spice ingredients | Quantity percent (by weight) |
|---|---|---|
| 1 | Black cardamom (Badi elaichi) | 05 |
| 2 | Cinnamon (Dalchini) | 20 |
| 3 | Turmeric (Haldi) | 10 |
| 4 | Cloves (Laung) | 05 |
| 5 | Red chilli (laal mirch) | 10 |
| 6 | Coriander powder (Dhania) | 20 |
| 7 | Cumin seeds (Zeera) | 10 |
| 8 | Black pepper(kalimirch) | 10 |
| 9 | Aniseed (Soanf) | 10 |

### *v. Refined wheat flour*

Refined wheat flour (RWF) or Maida of standard brand was procured from local market.

### *vi. Green banana pulp powder*

Green banana(Dwarf Cavendish) was purchased from local fruits shop. The fruits were manually peeled and the edible portion (pulp) was cut into 5 mm slices and immediately rinsed in 1% citric acid solution for 10 min to prevent enzymatic reaction as per the process mention by Karthikeyan, (2015) and Kumar *et al*., (2011). Banana slices were washed repeatedly with tap water and after draining off excess liquid, dried in a hot air oven at 60±2˚C till constant moisture content (10.0%). After dehydration, the dried slices were ground to powder form and stored at refrigeration temperature of 4°C in a pre sterilized low density polyethylene bags for further use.

## B. Preparation of chevon nuggets

Cooked Chevon nuggets were prepared as per method of the Nayak *et al*., (2015) with slight modification. The body fat, tendons and separable connective tissues trimmed off and kept in deep freezer at (–18±1˚C) overnight and then thawed, and cut in the small chunk and minced in the mincer. The minced meat is chopped in the bowl chopper then addition of salt and STPP, water in the farm of ice flakes, vegetable oil, spice mixture, green banana pulp powder in treatment and refined wheat flour for control and addition of Egg next emulsion filled in nugget box and kept for pressure cooking after 20-30 min. removed from cooker and kept for cooling then chevon nuggets were stored at refrigeration temperature (4±1˚C) in low density polyethylene (LDPE) pouches for shelf-life study.

## C. Physico-chemical Properties

### *i. pH*

The pH of chevon nuggets was determined by the method of Trout *et al*. (1992). 10 g of cooked chevon nuggets was made into fine suspension with addition of 50 ml distilled water and the pH of suspension was measured using digital pH meter.

### *ii. Thiobarbituric acid value*

TBA value was determined as per the method as described by Witte *et al*. (1970) and optical density was measured at 530 nm using Spectrophotometer.

**Table 2.** Basic formulation of chevon nuggets

| Sr. No | Ingredients | Quantity (% by weight) | |
|---|---|---|---|
| | | Control | T1 |
| 1 | Minced chevon meat | 55.00 | 55.00 |
| 2 | Salt | 01.80 | 01.80 |
| 3 | Sodium tripolyphosphate | 0.20 | 0.20 |
| 4 | Refined oil | 10.00 | 10.00 |
| 5 | Ice flakes | 14.00 | 14.00 |
| 6 | Dry spices mix | 03.00 | 03.00 |
| 7 | Refined Wheat Flour | 04.00 | -- |
| 8 | Green banana pulp powder | -- | 04.00 |
| 9 | Egg | 09.00 | 09.00 |
| 10 | Condiments | 03.00 | 03.00 |
| | Total | 100 | 100 |

### *iii. Tyrosine Value*

Tyrosine value of chevon nuggets samples was estimated by the extraction method of Strange *et al.* (1977). The absorbance (OD) was measured at 730 nm using Systronic Spec trophotometer. Tyrosine value was calculated as mg tyrosine per 100 g of meat sample by referring to the standard curve prepared as per the procedure of Pearson (1968).

## D. Microbiological quality

The microbiological quality of chevon nuggets was assessed based on total plate count (TPC), psychrophilic count and Coliform count at the end of storage as per the method of APHA (1992).

## E. Sensory evaluation

The sensory panellists consisting of academic staff members from College of Veterinary and Animal Sciences, Udgir were involved to assess the quality of chevon nuggets based on sensory attributes viz. appearance, flavour, juiciness, texture and overall acceptability using 8 point descriptive scale (Keeton,1983) where '8' denoted extremely desirable and '1'denoted extremely poor. The stored product was observed for any objectionable flavour and colour before evaluation. Chevon nuggets were warmed and then served hot to the sensory panellists for evaluation.

## F. Statistical analysis

Data originated from various treatment groups were analysed statistically using a completely randomized design (CRD) by following standard methods Snedecor and Cochran (1989). The analysis of data was done using SPSS software package version 20.0 and means were compared by using Duncan's multiple range test.

# RESULTS AND DISCUSSION

## Physico-chemical properties

Selected level of green banana pulp powder was incorporated in preparation of chevon nuggets and stored under refrigeration temperature (4±1˚C) was evaluated for physico-chemical properties at every 4 days interval till spoilage. From the Table No. 3 it is revealed the pH of chevon nuggets increased highly significantly ($P\leq 0.01$) throughout the storage period of 16$^{th}$ days of storage. This increase in the pH might be due to accumulation of bacterial metabolites and break down of meat protein. Present findings were similar with those of Rindhe *et al.* (2009) or cooked chicken nuggets, Jagtap *et al.* (2018) for chevon emulsion with carcia papaya and the results are congruent with the finding of Sakunde (2004) for chicken patties using various binder. Further, significant ($P\leq 0.05$) differences were observed for pH between control and treatment at every storage interval. Lower pH was observed in 4% green banana pulp powder incorporated chevon nuggets compared to control. It might be due to lower pH of green banana powder by Kumar *et al.* (2011). TBA values of chevon nuggets increased highly significantly ($P\leq 0.01$) throughout the storage period up to 16$^{th}$ days. Increase in TBA value might be due to lipid oxidation (Brewer *et al.*, 1992). Significant ($p<0.05$) difference were observed in control and treated chevon nuggets throughout the storage period indicating lipid oxidation and production of volatile metabolites, initial TBA values for control and T1 chevon nuggets were 0.26 and 0.20 mg MDA/kg and increased up to 1.03 and 0.97 on 16$^{th}$ days of storage, which were good within threshold limit of 1-2 MDA/kg of meat. Relatively lower values in green banana pulp powder treated products than control might be due to antioxidant property in green banana pulp powder observed by Talukdar and Sharma (2013). Initial tyrosine values for control and T1 chevon nuggets were 15.75 and 14.95 and increased up to 20.80 and 19.55 mg/100gm on 16$^{th}$ days of storage. Similar observation reported by Choudhary *et al.* (2019) for Japanese quail meat nuggets added with bengal gram flour.

## Microbiological quality

Storage related changes on microbiological quality of chevon meat nuggets incorporated with green banana pulp powder for total plate count, psychrophilic count and coliform count during refrigerated storage are presented in Table No. 4. It was revealed that total plate count increased highly significantly ($P<0.01$) in control and T1 with the progress of storage at refrigerated temperature. However, total plate count in 4% GBPP added chevon nuggets showed relatively lower count then the control products (4% RWF) throughout the storage period which is indicative of presence of polyphenols in GBPP that posse's antimicrobial activity. It may be due to green banana flour rich in vit. C, A, glutathione, flavonoids and phenolics which had potent antioxidant property (Suntharalingam and Ravindran 1993). Similar findings were observed by Singh and Raghuvanshi, (2012), Kumar *et al.* (2011) and Jagtap (2018). Psychrophilic count was not detected on 0 day but detected on 4$^{th}$ day in onwards increasing pattern during storage of nuggets up to 16$^{th}$ days of storage. Similar observation found by Kumar *et al.* (2011) for storage study of chicken nuggets formulated

**Table 3.** Effect of green banana pulp powder physico-chemical properties of chevon nuggets during refrigerated storage (4±1˚C)

| Types of product | Storage period (days) | | | | | Treatment means* |
|---|---|---|---|---|---|---|
| | 0 day | 4 day | 8 day | 12 day | 16 day | |
| | | | pH | | | |
| **Control** | 6.12 ± 0.06 | 6.22 ± 0.04 | 6.26 ± 0.02 | 6.42 ± 0.04 | 6.58 ± 0.04 | 6.32[a] |
| **T1** | 5.90 ± 0.04 | 6.10 ± 0.03 | 6.24 ± 0.09 | 6.32 ± 0.02 | 6.48 ± 0.06 | 6.20[b] |
| **Storage period mean**** | 6.01[a] | 6.16[b] | 6.25[c] | 6.37[d] | 6.53[e] | |
| | | | TBA value (mg MDA/kg) | | | |
| **Control** | 0.26±0.04 | 0.45±0.04 | 0.64±0.04 | 0.87±0.03 | 1.03±0.04 | 0.65[a] |
| **T1** | 0.20±0.02 | 0.40±0.02 | 0.60±0.03 | 0.84±0.03 | 0.97±0.03 | 0.60[b] |
| **Storage period mean**** | 0.23[a] | 0.42[b] | 0.62[c] | 0.85[d] | 1.00[e] | |
| | | | Tyrosine value (mg/100 gm) | | | |
| **Control** | 15.75±0.23 | 17.80±0.38 | 18.50±0.03 | 19.90±0.31 | 20.80±0.08 | 18.55[a] |
| **T1** | 14.95±0.20 | 15.50±0.19 | 16.70±0.01 | 17.95±0.17 | 19.55±0.16 | 16.93[b] |
| **Storage period mean**** | 15.35[a] | 16.65[b] | 17.60[c] | 18.92[d] | 20.17[e] | |

Control: 4% refined wheat flour and T1: 4 % green banana pulp powder
* Means bearing different superscripts between columns differ significantly (p<0.05)
**Means bearing different superscripts between columns differ highly significantly (p<0.01)

**Table 4.** Effect of green banana pulp powder on microbiological quality of chevon nuggets during refrigerated storage (4 + 1oC).

| Type-of Product | Storage period days | | | | | Treatment Means* |
|---|---|---|---|---|---|---|
| | 0 | 4 | 8 | 12 | 16 | |
| | | | Total plate count (log cfu/g) | | | |
| **Control** | 4.40 ± 0.03 | 5.53 ± 0.02 | 5.67 ± 0.08 | 5.87 ± 0.08 | 6.27 ± 0.05 | 5.55[a] |
| **T1** | 4.26 ± 0.06 | 5.37 ± 0.08 | 5.65 ± 0.09 | 5.80 ± 0.09 | 6.13 ± 0.05 | 5.44[b] |
| **Storage Period Mean**** | 4.33[a] | 5.45[b] | 5.66[c] | 5.83[d] | 6.2[e] | |
| | | | Total psychrophilic count (log cfu/g) | | | |
| **Control** | ND | 4.75±0.06 | 5.70±0.06 | 6.11±0.06 | 6.39±0.14 | 5.73[a] |
| **T1** | ND | 4.61±0.14 | 5.49±0.10 | 5.98±0.06 | 6.14±0.19 | 5.55[b] |
| **Storage Period Mean**** | | 4.68[a] | 5.59[b] | 6.04[c] | 6.26[d] | |
| | | | Total coliform count (log cfu/g) | | | |
| **Control** | ND | ND | ND | ND | ND | |
| **T1** | ND | ND | ND | ND | ND | |
| **Storage Period Mean** | | | | | | |

Control: 4% refined wheat flour and T1: 4 % green banana pulp powder
* Means bearing different superscripts between columns differ significantly (p<0.05)
**Means bearing different superscripts between columns differ highly significantly (p<0.01)

with green banana and soybean hulls flours. Significant (P≤0.05) differences were observed for psychrophilic count between control and treatment at every storage interval. Further, lower psychrophilic count was observed in chevon nuggets incorporated with 4% green banana pulp powder (T1) then control. It may be due to green banana flour rich in vit. C, A, glutathione, flavonoids and phenolics which have potent antioxidant property (Suntharalingam and Ravindran 1993). Coliform count was not detected during storage of product up to 16$^{th}$ days. It may be attributed due to higher temperature of cooking, hygienic handling and processing of the product.

## Sensory quality

The average score for sensory attributes of chevon nuggets during refrigerated storage (4±1°C) are presented in Table 5. The sensory quality of product revealed non-significant (P≥0.05) differences for appearance, colour, texture and juiciness among the treatment up to 4th day of storage and later it differ highly significantly (P≤0.01) from 4th day of storage to 16th day. The present finding was in consonance with Kumar *et al*. (2011) who reported significant declining trend for colour and appearance for quality and storability of chicken nuggets. Reduction in juiciness scores might be due to loss of moisture from the product during the storage. Similar observation found by Shinde *et al*. (2019) for Japanese quail meat nuggets using finger millet flour during refrigerated storage. Significant (P≤ 0.05) differences were observed for appearance score between control and treatment at every storage interval. Further, higher appearance score was observed in chevon nuggets incorporated with 4% green banana pulp powder (T1) then control. This decrease in appearance and colour may be due to oxidation of myoglobin and increase loss of moisture Kumar *et al.*(2011). The texture score of products decrease highly significantly (P≤0.01) throughout the storage period. This decrease in textural score might be due to release of moisture and depletion of fat during storage. Similar finding reported by Kumar *et al*. (2011) for chicken nuggets formulated with green banana and soybean hulls flours and Verma *et al*., (2013) for guava powder as an antioxidant dietary fibre in sheep meat nuggets. Flavour scores declined highly significantly (p<0.01) towards the end of storage in both products, the decline in flavour score might be due to increase lipid oxidation resulting in malonaldehyde formation, liberation of free fatty acids and increased microbial growth Gadekar *et al.*(2009). Similar findings are observed by Aamina *et al.*(2014) for sensory and

**Table 5.** Effect of green banana pulp powder on sensory attributes of chevon nuggets during refrigerated storage (4 + 1oC)

| Type of products | Storage period (days) | | | | | Treatment means* |
|---|---|---|---|---|---|---|
| | 0 | 4 | 8 | 12 | 16 | |
| **Appearance** | | | | | | |
| **Control** | 6.92 ± 0.04 | 6.82 ±0.16 | 6.58 ± 0.04 | 6.02 ± 0.04 | 5.16 ± 0.08 | 6.30$^{b}$ |
| **T1** | 7.14 ± 0.10 | 7.14 ± 0.19 | 6.60 ± 0.10 | 6.16 ± 0.02 | 5.52 ± 0.02 | 6.51$^{a}$ |
| **Storage period mean**** | 7.03$^{a}$ | 6.98$^{a}$ | 6.59$^{b}$ | 6.09$^{c}$ | 5.34$^{d}$ | |
| **Flavour** | | | | | | |
| **Control** | 7.14 ± 0.05 | 6.88 ± 0.05 | 6.74 ± 0.02 | 6.10 ± 0.18 | 5.66 ± 0.10 | 6.50$^{b}$ |
| **T1** | 7.26 ± 0.08 | 7.12 ± 0.06 | 6.86 ± 0.07 | 6.38 ± 0.10 | 6.00 ± 0.05 | 6.72$^{a}$ |
| **Storage period mean**** | 7.20$^{a}$ | 7.00$^{b}$ | 6.80$^{c}$ | 6.24$^{d}$ | 5.83$^{e}$ | |
| **Juiciness** | | | | | | |
| **Control** | 6.72 ± 0.09 | 6.58 ± 0.12 | 6.30 ± 0.18 | 6.06 ± 0.20 | 5.58 ± 0.09 | 6.25$^{b}$ |
| **T1** | 6.98 ± 0.10 | 6.82 ± 0.16 | 6.40 ± 0.09 | 6.36 ± 0.07 | 6.04 ± 0.05 | 6.52$^{a}$ |
| **Storage period mean**** | 6.85$^{a}$ | 6.7$^{a}$ | 6.35$^{b}$ | 6.21$^{b}$ | 5.81$^{c}$ | |
| **Texture** | | | | | | |
| **Control** | 6.98 ± 0.05 | 6.88 ± 0.04 | 6.58 ± 0.04 | 6.24 ± 0.08 | 5.46 ± 0.05 | 6.43$^{b}$ |
| **T1** | 7.16 ± 0.05 | 7.00 ± 0.03 | 6.66 ± 0.05 | 6.36 ± 0.12 | 5.62 ± 0.15 | 6.56$^{a}$ |
| **Storage period mean**** | 7.07$^{a}$ | 6.94$^{a}$ | 6.62$^{b}$ | 6.30$^{c}$ | 5.54$^{d}$ | |
| **Overall palatability** | | | | | | |
| **Control** | 6.86 ± 0.04 | 6.62 ± 0.06 | 6.44 ± 0.07 | 5.84 ± 0.15 | 5.38 ± 0.10 | 6.23$^{b}$ |
| **T1** | 7.04 ± 0.05 | 6.86 ± 0.05 | 6.82 ± 0.04 | 6.10 ± 0.04 | 5.88 ± 0.07 | 6.54$^{a}$ |
| **Storage period mean**** | 6.95$^{a}$ | 6.74$^{b}$ | 6.63$^{b}$ | 5.97$^{c}$ | 5.63$^{d}$ | |

Control: 4% refined wheat flour and T1: 4 % green banana pulp powder

* Means bearing different superscripts between columns differ significantly (p<0.05)

** Means bearing different superscripts between columns differ highly significantly (p<0.01)

textural properties of mutton nuggets. Significant (P≤0.05) differences were observed for flavour score between control and treatment at every storage interval. Further, higher flavour score was observed in chevon nuggets incorporated with 4% green banana pulp powder (T1) then control this was may be due to increase of fat loss Kumar *et al.* (2011). Overall palatability score of goat meat nuggets was declining during progress of storage. The palatability score was decreased highly significantly (p<0.01) during entire storage period in both the products. Overall palatability were revealed significant (P≤ 0.05) higher score in chevon nuggets incorporated with 4% green banana pulp powder (T1) then control.

# CONCLUSION

Incorporation of 4% green banana pulp powder had some beneficial effect on different physico-chemical, microbiological and sensory quality of chevon nuggets stored at refrigerated storage (4 ± 1°C) temperature. On the basis of observation it could concluded that incorporation of 4% green banana pulp powder was suitable for enhancing the quality of chevon nuggets at refrigerated (4 ± 1°C) storage temperature.

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# DECLARATION OF INTEREST STATEMENT

The authors declare that there is no conflict of interests regarding the publication of this article.

# AUTHORS' CONTRIBUTION

All authors contributed equally to this study.

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