



*Original Research*

## Shelf Life Evaluation of Chicken Meat Nuggets Incorporated With Gooseberry (Pulp and Seed Coat) Powder as Natural Preservatives at Refrigerated Storage ( $4\pm 1^{\circ}\text{C}$ )

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### Abstract

Antimicrobial effect of gooseberry pulp powder (GPP) and gooseberry seed coat powder (GSCP) were used as natural preservative in spent-hen meat nuggets. Treated product along with control were studied for their physico-chemical, proximate analysis and sensory quality during storage at refrigerated temperature ( $4\pm 1^{\circ}\text{C}$ ). With the advancement of storage period, the values of pH, TBARS and microbiological count increased significantly ( $p\leq 0.05$ ) in all samples. Coliform counts were not observed during the complete storage period. Proximate analysis of the products showed non-significant ( $p>0.05$ ) effect with increasing storage period, however there was a significant ( $p\leq 0.05$ ) increase in the moisture content. The sensory attributes were decreased significantly ( $p\leq 0.05$ ) in all samples of nuggets during storage at refrigerated temperature ( $4\pm 1^{\circ}\text{C}$ ). On the basis of results obtained, it is concluded that nuggets prepared with incorporation of GPP and GSCP had better shelf life and are highly acceptable than control.

**Key words:** Gooseberry Pulp-Powder, Gooseberry Seed Coat Powder, Spent Hen Meat Nuggets, Storage Study

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### Introduction

Meat is considered as nutrient rich food and is valuable in planning healthy diets (Kondaiah *et al.*, 2002). Price of unit chicken is much cheaper than mutton and chevon, as chicken meat is free from all religious taboos. Moreover, it also contains high quality protein. Owing to the phenomenal expansion of Indian



chicken industry in global sector, accessibility of culled and spent hen has increased up to many folds. Egg producers worldwide dispose of about 2.60 billion spent hens annually (Singh *et al.*, 2001). These culled stocks which are pondering as poor meat for its higher toughness, less juiciness, high collagen content (Abe *et al.*, 1996) as contrast to the broiler. As a result, producers do not get remunerative prices; also consumers do not prefer such meat. Additionally, proper disposal of these spent hen meat is a problem for traders. Thus, there arises a need to search better alternatives for using spent hen meat.

The gooseberries (*Emblica officinalis*) has an unique and hallowed position in Ayurveda. It is native to India and grown simultaneously in tropical and subtropical regions of South East Asia (Liu *et al.*, 2008). These gooseberries also have antimicrobial activities against various microorganisms. The fruit contains several components which are effective against pathogens like *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumonia*, *Pasteurellamultocida*, *Streptococcus pyogenes*, *Vibrio cholerae*, *Pseudomonas aeruginosa* (Patil *et al.*, 2012). Usually, gooseberry seed coat is discarded as waste after utilization. Such waste product (seed coat) should be utilized because it contains higher fibre and shows good anti-oxidants and antimicrobial activity. Seed coat powder contained higher water holding capacity and swelling capacity compared to gooseberry pulp powder (Goswami *et al.*, 2017).

Development of novel products from these type of spent hen meat seems to be a better prospect for consumers due to low prices and high fat content and hence more suitable for processing (Kondaiah and Panda, 1992). It will also lead to enhancement of rheological characteristics and value addition. Recently spent hen and its by-products holds an important position in Indian market due to its availability. Among the variety of convenient meat products, chicken nuggets occupy a predominant place worldwide. Looking at the facts and figures mentioned above, a study was designed to observe the effectiveness of gooseberry (*Emblica officinalis*) pulp and its seed coat powder as preservative in chicken nuggets.

## Materials and Methods

### Procurement of Raw Materials, Chemicals and Media

The spent hen meat above 52 weeks of age was procured from local market of Palanpur, Gujarat. Gooseberry, spices, condiments, refined wheat flour, table salt and refined oil were obtained from local market (Dantiwada, Gujarat). Chemicals and microbiological medias were procured from Hi-Media Laboratories Limited, Mumbai.

### Preparation of Chicken Nuggets

Chicken nuggets were prepared by following the procedure of Verma *et al.* (2013).

### **Gooseberry Powder**

The gooseberry fruits were cleaned thoroughly under tap water to remove adhering dust and wiped out with a muslin cloth. The fleshy part of gooseberry was grated and seed coat was separated manually. Gooseberry shreds were dried in hot air oven at 40-60°C for 48 hrs. As the whole seeds were dried, they were broken along the ridges with a crackling sound. The seed coat was separated from the brown seed from each of the broken units. Finally, the dried gooseberry pulp and seed coat were grinded (Kenstar, Karishma), sieved through a fine mesh and stored at refrigerated temperature (4°C) till further use.

### **Estimation of Physico-Chemical Characteristic of Chicken Nuggets**

#### **Estimation of TBA Value in Control and Treated Nuggets**

The method of Witte *et al.* (1970) was followed for Thiobarbituric acid (TBA) value in fresh as well as in stored nuggets.

#### **pH**

For determination of pH, each treated nuggets were blended with distill water (five times the weight of the sample) to get uniform suspension. The pH was recorded by (pH analyzer LI 614 Elico) immersing electrode into aliquot of the sample till the value become stable.

#### **Proximate Analysis**

The product prepared was subjected to proximate analysis determined as per Association of Official Analytical Chemist (AOAC 1995) method i.e. moisture, protein, fat (ether extract (EE), crude fibre and total ash.

#### **Microbiological Analysis**

The products prepared were subjected to microbial analysis and determined as per American Public Health Association (APHA, 1992). The different microbiological aspects determined were: Total plate count, coliform count, yeast and mould count, psychrophilic counts.

#### **Sensory Evaluation of Spent Hen Meat Nuggets**

The sensory quality of sample was evaluated using 8-point descriptive scale (Keeton *et al.*, 1983) whereas sensory analysis was conducted by sensory panel of seven semi-trained judges.

#### **Storage Stability and Shelf Life of Spent Hen Nuggets**

Chicken nuggets with best sensory attributes along with control was packed in low-density polyethylene (LDPE) pouches and was stored at refrigerated temperature (4±1°C). The quality changes in the nuggets were evaluated after drawing sample periodically at 0, 5, 10, 15 and 20 days of storage.

## Statistical Analysis

Statistical analysis of the data obtained was carried out as per the methods described by Snedecor and Cochran (1994).

## Results and Discussion

**Table 1:** Effect of GPP and GSCP on physio-chemical characteristics of chicken nuggets (mean  $\pm$  S.E).

Treatments	Storage at Refrigeration Temperature (4 $\pm$ 1°C)				
	0 day	5 day	10 day	15 day	20 day
<b>pH</b>					
Control	6.16 $\pm$ 0.06 <sup>AA</sup>	6.22 $\pm$ 0.06 <sup>BA</sup>	6.36 $\pm$ 0.06 <sup>CA</sup>	6.48 $\pm$ 0.05 <sup>DA</sup>	6.66 $\pm$ 0.05 <sup>EA</sup>
0.5 % GPP	6.03 $\pm$ 0.04 <sup>AB</sup>	6.11 $\pm$ 0.57 <sup>BB</sup>	6.20 $\pm$ 0.04 <sup>CB</sup>	6.32 $\pm$ 0.05 <sup>DB</sup>	6.46 $\pm$ 0.05 <sup>EB</sup>
1.5 % GSCP	6.09 $\pm$ 0.07 <sup>AC</sup>	6.18 $\pm$ 0.06 <sup>BC</sup>	6.24 $\pm$ 0.01 <sup>CC</sup>	6.38 $\pm$ 0.01 <sup>DC</sup>	6.51 $\pm$ 0.06 <sup>EC</sup>
<b>TBA Values (mg malonaldehyde/kg)</b>					
Control	0.37 $\pm$ 0.08 <sup>AA</sup>	0.43 $\pm$ 0.05 <sup>BA</sup>	0.63 $\pm$ 0.05 <sup>CA</sup>	0.76 $\pm$ 0.08 <sup>DA</sup>	0.94 $\pm$ 0.06 <sup>EA</sup>
0.5 % GPP	0.21 $\pm$ 0.05 <sup>AB</sup>	0.27 $\pm$ 0.06 <sup>BB</sup>	0.39 $\pm$ 0.05 <sup>CB</sup>	0.51 $\pm$ 0.01 <sup>DB</sup>	0.66 $\pm$ 0.07 <sup>EB</sup>
1.5 % GSCP	0.26 $\pm$ 0.05 <sup>AC</sup>	0.35 $\pm$ 0.01 <sup>BC</sup>	0.49 $\pm$ 0.09 <sup>CC</sup>	0.68 $\pm$ 0.09 <sup>DC</sup>	0.84 $\pm$ 0.05 <sup>EC</sup>
<b>Total Plate Count</b>					
Control	1.95 $\pm$ 0.05 <sup>AA</sup>	2.48 $\pm$ 0.03 <sup>BA</sup>	3.20 $\pm$ 0.04 <sup>CA</sup>	4.64 $\pm$ 0.05 <sup>DA</sup>	5.10 $\pm$ 0.06 <sup>EA</sup>
0.5 % GPP	1.70 $\pm$ 0.05 <sup>AB</sup>	2.05 $\pm$ 0.05 <sup>BB</sup>	2.70 $\pm$ 0.01 <sup>CB</sup>	3.50 $\pm$ 0.01 <sup>DB</sup>	4.32 $\pm$ 0.06 <sup>EB</sup>
1.5 % GSCP	1.82 $\pm$ 0.04 <sup>AC</sup>	2.2 $\pm$ 0.08 <sup>BC</sup>	2.95 $\pm$ 0.03 <sup>CC</sup>	3.88 $\pm$ 0.07 <sup>DC</sup>	4.78 $\pm$ 0.05 <sup>EC</sup>
<b>Psychrophilic Count</b>					
Control	NF	1.62 $\pm$ 0.03 <sup>AA</sup>	2.35 $\pm$ 0.05 <sup>BA</sup>	3.12 $\pm$ 0.06 <sup>CA</sup>	3.54 $\pm$ 0.06 <sup>DA</sup>
0.5 % GPP	NF	1.42 $\pm$ 0.06 <sup>AB</sup>	2.2 $\pm$ 0.06 <sup>BB</sup>	2.84 $\pm$ 0.05 <sup>CB</sup>	3.30 $\pm$ 0.05 <sup>DB</sup>
1.5 % GSCP	NF	1.48 $\pm$ 0.09 <sup>AC</sup>	2.28 $\pm$ 0.04 <sup>BC</sup>	2.95 $\pm$ 0.03 <sup>CC</sup>	3.43 $\pm$ 0.03 <sup>DC</sup>
<b>Yeast and Mould Count</b>					
Control	N.F	1.54 $\pm$ 0.05 <sup>AA</sup>	1.73 $\pm$ 0.05 <sup>BA</sup>	2.25 $\pm$ 0.03 <sup>CA</sup>	3.66 $\pm$ 0.07 <sup>DA</sup>
0.5 % GPP	N.F	1.28 $\pm$ 0.03 <sup>AB</sup>	1.54 $\pm$ 0.03 <sup>BB</sup>	2.06 $\pm$ 0.04 <sup>CB</sup>	3.22 $\pm$ 0.07 <sup>DB</sup>
1.5 % GSCP	N.F	1.42 $\pm$ 0.05 <sup>AC</sup>	1.62 $\pm$ 0.06 <sup>BC</sup>	2.12 $\pm$ 0.05 <sup>CC</sup>	3.38 $\pm$ 0.07 <sup>DC</sup>

Mean  $\pm$  S.E with different small letter superscripts in rows and capital letter superscripts in columns within each parameter differ significantly ( $p \leq 0.05$ );  $n=6$ .

There was a significant ( $p \leq 0.05$ ) increase in pH, TBA, TPC, psychrophilic count, yeast and mould counts in control, GPP and GSCP incorporated nuggets with advancement of storage period. During the study, psychrophilic count, yeast and mould count was not observed on 0<sup>th</sup> day of storage. Coliforms were not detected in both control and treatment groups. At the 20<sup>th</sup> day of storage the values of all parameters viz. pH, TBA, TPC, psychrophilic count, yeast and mould counts were recorded highest for control and lowest for GPP added samples. After the 20<sup>th</sup> day of sensory evaluation, GPP added products were not acceptable by the sensory panel, so further physico-chemical analysis was stopped for aerobic packaged nuggets.

A significant ( $p \leq 0.05$ ) decrease in pH was observed in the products with the incorporation of GPP and GSCP. This is attributable to the innate pH of the GPP which was estimated as 2.58 and acid terminal residues in the starch molecules produced by depolymerisation of starch granules during cooking (Perez, 1997). Increase in pH during storage period may be due to bacterial growth which lead to increased

breakdown of meat proteins and production of amines during storage of samples. Result of above findings were in accordance with the studies conducted by Giriprasad *et al.* (2015) and Bariya *et al.* (2016) who observed an increase in pH from 10<sup>th</sup> day of storage in buffalo meat steaks and goat meat patties. In contrast to the above findings Zargar *et al.* (2014) found a decrease in the pH value of chicken meat sausage incorporated with pumpkin powder. It was reported that addition of GPP and GSCP have significantly ( $p \leq 0.05$ ) reduced the TBA values of nuggets during the storage period. This might be because, both GPP and GSCP are good sources of antioxidant (Mishra and Mhanta, 2014). These results were matched with Giriprasad *et al.* (2015) in buffalo meat steaks, the TBA values were significantly low in mousambi peel and amla powder treated steaks. Bariya *et al.* (2016) reported significantly lower TBA value of both amla pulp and amla seed coat extract treated goat meat patties than control. Similar findings were observed by Kumar *et al.* (2015) in pork patties, Mielnik *et al.* (2006) in turkey meat and Bhat *et al.* (2017) in chicken cutlets.

At the end of the storage GPP treated sample were found to be lowest in TPC whereas yeast and mould count was below the permissible limit i.e. within 7 log<sub>10</sub> cfu for cooked meat products (Jay, 1996). It might be due to antimicrobial properties of both powders. Similar results were reported by Bali *et al.* (2011) who compared antimicrobial properties of garlic and coriander on chicken sausage and Singh *et al.* (2014) who studied preservative effect of clove powder, ginger and garlic paste in raw chicken emulsion. Coliform counts were not observed in either of the samples during storage period. It could be possible due to cooking of product to an internal temperature of 72°C, which might have been lethal to the coliforms and reflecting the good hygienic practices during the processing of products. Similar results were also obtained by Kumar *et al.* (2010) who added green banana and soybean hulls flour in chicken nuggets. These findings were supported by Malav *et al.* (2013) and Bhat *et al.* (2017). Psychrophilic counts were not detected on 0<sup>th</sup> day of storage in the treated as well as control but it was quite detectable in 5<sup>th</sup> day of storage in both the groups. This could be due to the destruction of psychrophiles during cooking (Giriprasad *et al.*, 2015). Psychrophiles constantly remained lower than the log 10<sup>th</sup> value of threshold level (4 cfu/g) for acceptability of cooked meat products (Jay, 1996). Naveena *et al.* (2008), found buffalo meat steaks incorporated with either lactic acid + clove or lactic acid + clove + vitamin C had significantly ( $p \leq 0.05$ ) lower psychrophiles than control or lactic acid treated samples. In contrast, Malav *et al.* (2013) found that on 15<sup>th</sup> day of storage psychrophilic colonies for both the treatments were significantly higher ( $p \leq 0.05$ ) than control.

**Table 2:** Effect of GPP and GSCP on sensory characteristics of chicken nuggets (mean  $\pm$  S.E)

Treatments	Storage at refrigeration temperature (4 $\pm$ 1°C)				
	Colour and appearance				
	0 day	5 day	10 day	15 day	20 day
Control	7.50 $\pm$ 0.09 <sup>aA</sup>	7.30 $\pm$ 0.03 <sup>bA</sup>	6.90 $\pm$ 0.03 <sup>cA</sup>	6.60 $\pm$ 0.07 <sup>dA</sup>	6.20 $\pm$ 0.07 <sup>eA</sup>
0.5 % GPP	7.30 $\pm$ 0.06 <sup>aB</sup>	7.12 $\pm$ 0.03 <sup>abA</sup>	7.04 $\pm$ 0.03 <sup>bcA</sup>	6.91 $\pm$ 0.05 <sup>cB</sup>	6.70 $\pm$ 0.04 <sup>dB</sup>
1.5 % GSCP	7.20 $\pm$ 0.06 <sup>aB</sup>	7.10 $\pm$ 0.02 <sup>aC</sup>	6.90 $\pm$ 0.03 <sup>aA</sup>	6.80 $\pm$ 0.05 <sup>cB</sup>	6.50 $\pm$ 0.01 <sup>cC</sup>
Flavour					
Control	7.40 $\pm$ 0.03 <sup>aA</sup>	7.30 $\pm$ 0.01 <sup>bA</sup>	7.00 $\pm$ 0.03 <sup>cA</sup>	6.85 $\pm$ 0.03 <sup>dA</sup>	6.76 $\pm$ 0.03 <sup>eA</sup>
0.5 % GPP	7.35 $\pm$ 0.07 <sup>aA</sup>	7.27 $\pm$ 0.01 <sup>bA</sup>	7.07 $\pm$ 0.09 <sup>cB</sup>	6.92 $\pm$ 0.01 <sup>dA</sup>	6.70 $\pm$ 0.06 <sup>eB</sup>
1.5 % GSCP	7.20 $\pm$ 0.02 <sup>aB</sup>	7.08 $\pm$ 0.02 <sup>bB</sup>	6.88 $\pm$ 0.02 <sup>cC</sup>	6.73 $\pm$ 0.01 <sup>dB</sup>	6.65 $\pm$ 0.01 <sup>eB</sup>
Juiciness					
Control	7.20 $\pm$ 0.05 <sup>aA</sup>	7.11 $\pm$ 0.06 <sup>bA</sup>	6.85 $\pm$ 0.06 <sup>cA</sup>	6.74 $\pm$ 0.07 <sup>dA</sup>	6.60 $\pm$ 0.05 <sup>eA</sup>
0.5 % GPP	7.24 $\pm$ 0.07 <sup>aB</sup>	7.18 $\pm$ 0.05 <sup>bB</sup>	7.05 $\pm$ 0.06 <sup>cB</sup>	6.94 $\pm$ 0.05 <sup>dB</sup>	6.82 $\pm$ 0.06 <sup>eB</sup>
1.5 % GSCP	7.32 $\pm$ 0.05 <sup>aC</sup>	7.26 $\pm$ 0.05 <sup>bC</sup>	7.12 $\pm$ 0.04 <sup>cC</sup>	7.01 $\pm$ 0.05 <sup>dC</sup>	6.88 $\pm$ 0.07 <sup>eC</sup>
Texture					
Control	7.22 $\pm$ 0.05 <sup>aA</sup>	7.10 $\pm$ 0.06 <sup>bA</sup>	6.98 $\pm$ 0.05 <sup>bA</sup>	6.67 $\pm$ 0.04 <sup>cA</sup>	6.45 $\pm$ 0.04 <sup>dA</sup>
0.5 % GPP	7.34 $\pm$ 0.01 <sup>aA</sup>	7.16 $\pm$ 0.06 <sup>bA</sup>	7.00 $\pm$ 0.06 <sup>cA</sup>	6.83 $\pm$ 0.04 <sup>dB</sup>	6.56 $\pm$ 0.06 <sup>eB</sup>
1.5 % GSCP	7.30 $\pm$ 0.05 <sup>aA</sup>	7.15 $\pm$ 0.05 <sup>bA</sup>	6.97 $\pm$ 0.04 <sup>cA</sup>	6.80 $\pm$ 0.03 <sup>dB</sup>	6.70 $\pm$ 0.05 <sup>eA</sup>
Overall acceptability					
<b>Control</b>	7.35 $\pm$ 0.04 <sup>aA</sup>	7.22 $\pm$ 0.04 <sup>bA</sup>	7.05 $\pm$ 0.04 <sup>cA</sup>	6.85 $\pm$ 0.05 <sup>dA</sup>	6.60 $\pm$ 0.03 <sup>eA</sup>
<b>0.5 % GPP</b>	7.20 $\pm$ 0.06 <sup>aB</sup>	7.10 $\pm$ 0.04 <sup>abA</sup>	6.96 $\pm$ 0.02 <sup>cA</sup>	6.82 $\pm$ 0.02 <sup>dA</sup>	6.70 $\pm$ 0.06 <sup>eA</sup>
<b>1.5 % GSCP</b>	7.12 $\pm$ 0.01 <sup>aB</sup>	7.00 $\pm$ 0.02 <sup>abB</sup>	6.88 $\pm$ 0.02 <sup>cB</sup>	6.67 $\pm$ 0.01 <sup>dB</sup>	6.50 $\pm$ 0.07 <sup>eB</sup>

Mean  $\pm$  S.E with different small letter superscripts in rows and capital letter superscripts in columns within each parameter differ significantly ( $p \leq 0.05$ );  $n=6$ .

In sensory evaluation, all the characteristics like colour, appearance, flavour, juiciness, texture and overall acceptability indicated significant ( $p \leq 0.05$ ) decreasing trend after 5<sup>th</sup> day of storage period at refrigeration temperature in both control and treatment nuggets. At the end of storage study, GPP incorporated nuggets showed highest sensory score compared to control and GSCP. Decrease in scores of colour and appearance could be due to lipid oxidation, non-enzymatic browning as well as surface dehydration in LDPE packaging. These findings are in agreement with the observations of Najeeb *et al.* (2014) in restructured chicken slices. Bariya *et al.* (2016) observed that goat meat patties packed in LDPE had developed yellowish light brown colour after 15 days of storage. Nayak *et al.* (2015) also reported similar result by caragreen added low-fat nuggets.

There was significant decline in juiciness of nuggets which could be due to loss of moisture from the products during storage and presence of oxygen inside the aerobic packaging. Similar to the present findings, Zargar *et al.* (2014) observed significant ( $p \leq 0.05$ ) decrease in juiciness of chicken sausages prepared with pumpkin as well as control throughout the storage period. The results were in accordance with findings of Thomas *et al.* (2006) and Najeeb *et al.* (2014). Significant decrease in flavour scores might be due to development of oxidative rancidity and microbial deterioration in products. Similar findings were reported by Najeeb *et al.* (2014) in restructured chicken slices incorporated with fruits (red grapes,

gooseberry and tomato) powder. Bariya *et al.* (2016) use gooseberry pulp and gooseberry seed coat extract in goat meat patties. A decrease in texture during storage was observed in control as well as GPP and GSCP powder added nuggets. Higher texture score for GSCP incorporated nuggets might be due to its higher fibre contain compared to GPP. Decline in textural scores could be due to denaturation of proteins at low pH and degradation of muscle fibre proteins by bacterial action (Jay, 1996), which resulted in decreased water binding capacity. Bali *et al.* (2011) incorporated garlic and coriander powder in chicken sausage which was stored at refrigerated temperature and observed that it produces the similar results wherein garlic group was superior than coriander and control. The results were in accordance with findings of reduction in texture scores during storage period which have also been reported by Malav *et al.* (2013), Das *et al.* (2013) and Zagar *et al.* (2014).

**Table 3:** Effect of GPP and GSCP on proximate composition of chicken nuggets (mean  $\pm$  S.E)

Treatments	Storage at Refrigeration Temperature (4 $\pm$ 1°C)				
	Moisture				
	0 day	5 day	10 day	15 day	20 day
Control	63.25 $\pm$ 0.02 <sup>aA</sup>	63.28 $\pm$ 0.02 <sup>abA</sup>	63.30 $\pm$ 0.02 <sup>abA</sup>	63.32 $\pm$ 0.01 <sup>bA</sup>	63.49 $\pm$ 0.002 <sup>cA</sup>
0.5 % GPP	63.23 $\pm$ 0.01 <sup>aB</sup>	63.31 $\pm$ 0.09 <sup>bB</sup>	63.36 $\pm$ 0.01 <sup>bB</sup>	63.43 $\pm$ 0.01 <sup>cB</sup>	63.50 $\pm$ 0.08 <sup>dB</sup>
1.5 % GSCP	63.27 $\pm$ 0.03 <sup>aC</sup>	63.38 $\pm$ 0.03 <sup>bC</sup>	63.45 $\pm$ 0.01 <sup>cC</sup>	63.53 $\pm$ 0.002 <sup>dC</sup>	63.75 $\pm$ 0.04 <sup>eC</sup>
Crude Protein					
Control	18.84 $\pm$ 0.05 <sup>aA</sup>	18.78 $\pm$ 0.05 <sup>bA</sup>	18.74 $\pm$ 0.07 <sup>cA</sup>	18.75 $\pm$ 0.05 <sup>dA</sup>	18.80 $\pm$ 0.04 <sup>deA</sup>
0.5 % GPP	18.68 $\pm$ 0.05 <sup>aB</sup>	18.73 $\pm$ 0.56 <sup>bB</sup>	18.62 $\pm$ 0.05 <sup>cB</sup>	18.64 $\pm$ 0.0505 <sup>dB</sup>	18.66 $\pm$ 0.05 <sup>eB</sup>
1.5 % GSCP	18.54 $\pm$ 0.06 <sup>aC</sup>	18.61 $\pm$ 0.08 <sup>bC</sup>	18.56 $\pm$ 0.05 <sup>cC</sup>	18.54 $\pm$ 0.05 <sup>cC</sup>	18.55 $\pm$ 0.04 <sup>aC</sup>
Ether Extract					
Control	14.63 $\pm$ 0.08 <sup>aA</sup>	14.62 $\pm$ 0.06 <sup>aA</sup>	14.58 $\pm$ 0.05 <sup>bA</sup>	14.59 $\pm$ 0.06 <sup>bA</sup>	14.65 $\pm$ 0.06 <sup>cA</sup>
0.5 % GPP	14.22 $\pm$ 0.07 <sup>aB</sup>	14.23 $\pm$ 0.08 <sup>abB</sup>	14.25 $\pm$ 0.04 <sup>cB</sup>	14.24 $\pm$ 0.05 <sup>cdB</sup>	14.21 $\pm$ 0.04 <sup>aB</sup>
1.5 % GSCP	14.12 $\pm$ 0.08 <sup>aC</sup>	14.10 $\pm$ 0.06 <sup>bc</sup>	14.08 $\pm$ 0.06 <sup>bc</sup>	14.08 $\pm$ 0.06 <sup>bc</sup>	14.09 $\pm$ 0.05 <sup>bc</sup>
Total Ash					
Control	2.38 $\pm$ 0.03 <sup>aC</sup>	2.40 $\pm$ 0.08 <sup>aC</sup>	2.35 $\pm$ 0.07 <sup>bC</sup>	2.35 $\pm$ 0.14 <sup>bC</sup>	2.31 $\pm$ 0.05 <sup>cC</sup>
0.5 % GPP	2.56 $\pm$ 0.07 <sup>aA</sup>	2.57 $\pm$ 0.08 <sup>aA</sup>	2.54 $\pm$ 0.08 <sup>bA</sup>	2.54 $\pm$ 0.05 <sup>bA</sup>	2.50 $\pm$ 0.05 <sup>cA</sup>
1.5 % GSCP	2.45 $\pm$ 0.05 <sup>acB</sup>	2.47 $\pm$ 0.06 <sup>aB</sup>	2.43 $\pm$ 0.05 <sup>cB</sup>	2.44 $\pm$ 0.08 <sup>cB</sup>	2.40 $\pm$ 0.04 <sup>dB</sup>
Crude Fibre					
Control	0.60 $\pm$ 0.06 <sup>aA</sup>	0.59 $\pm$ 0.07 <sup>abA</sup>	0.57 $\pm$ 0.05 <sup>bcA</sup>	0.58 $\pm$ 0.07 <sup>abA</sup>	0.55 $\pm$ 0.06 <sup>cA</sup>
0.5 % GPP	0.75 $\pm$ 0.08 <sup>abB</sup>	0.73 $\pm$ 0.07 <sup>bcB</sup>	0.72 $\pm$ 0.06 <sup>cB</sup>	0.75 $\pm$ 0.08 <sup>aB</sup>	0.75 $\pm$ 0.04 <sup>abB</sup>
1.5 % GSCP	0.87 $\pm$ 0.07 <sup>aC</sup>	0.85 $\pm$ 0.06 <sup>abC</sup>	0.84 $\pm$ 0.06 <sup>bc</sup>	0.85 $\pm$ 0.05 <sup>abC</sup>	0.87 $\pm$ 0.05 <sup>aC</sup>

Mean  $\pm$  S.E with different small letter superscripts in rows and capital letter superscript in columns within each parameter differ significantly ( $p \leq 0.05$ ).

During storage study, overall acceptability of product decreases which might be due to decline in value of other sensory characteristics, increased fat oxidation, protein degradation and mild off flavour due to fat degradation. These findings were in agreement with the findings of Malav *et al.* (2013) who evaluated chicken meat blocks with sorghum flour and potato in which they found significant decrease in overall acceptability scores for treatment products as compared to control. Similar trends of reduction in overall

acceptability scores at the end of storage period have also been reported by Zagar *et al.* (2014), Giriprasad *et al.* (2015) and Najeeb *et al.* (2014).

The moisture value of all nugget samples were significantly increased ( $p \leq 0.05$ ) during storage period which may be due to the permeability of low-density polyethylene to the water vapour. Chicken nuggets incorporated with 1.5% GSCP showed highest value for moisture during the entire storage period as compared to control and GPP incorporated nuggets which could be because the seed coat powder contained higher water holding capacity and swelling capacity with mean value of 9.5 g water/g dry water basis and 12.86 mL water/g dwb (Goswami *et al.*, 2017). Similar results were also found by Kumar *et al.* (2010) who incorporated green banana flour and soya hull flour in chicken nuggets. Fernandes-gines *et al.* (2004) reported cooked lamon albedo fibres (2.5-5 %) in bolongas sausages which showed higher moisture content than control. During storage period there was no significant change in crude protein and ether extract (EE) value of spent hen meat nuggets. Control nuggets showed highest value for crude protein and EE during entire storage period as compared to the GPP and GSCP incorporated nuggets. The lower protein and EE content of treatment groups might due to replacement of lean meat by GPP and GSCP which is low in fat content. Verma *et al.* (2012) studied the effect of sodium chloride replacement and added hull flour in chicken nuggets in which they found fat content remained almost similar ( $p > 0.05$ ) for control and treatment groups. Singh *et al.* (2011) also found non-significant change in fat during 30 days of storage period at  $30 \pm 2^\circ\text{C}$ . Bhattacharya *et al.* (2017) studied the effect of date palm fruit added in chicken nuggets in which they found fat content remained almost similar ( $p > 0.05$ ) for control and treatment groups.

The incorporation of GPP and GSCP in nuggets results in higher ash content of the nuggets as compared to control. Results were in agreement with Das *et al.* (2013) who found that fermented bamboo shoot incorporated with chicken nuggets registered higher total ash content as compared to the control. The results were also in accordance with the findings of Verma *et al.* (2012) and Singh *et al.* (2011). GSCP nuggets showed non-significant values for crude fibre during entire storage period as compared to the control and GPP added nuggets. Das *et al.* (2013) reported significantly higher ( $p \leq 0.01$ ) contents of crude fibre in treated nuggets as compared to the control product. Verma *et al.* (2010) observed that there was significant ( $p \leq 0.05$ ) increase in dietary fibre content of chicken nuggets by sodium chloride replacement and apple pulp inclusion. As per the above findings Kumar *et al.* (2013) tried a combination of green banana and soybean hulls flours in chicken nuggets and evidenced similar results. Reddy *et al.* (2017) studied the effect of cereal flour in chicken meat sausage and experienced similar results.

## Conclusion

The present study showed that incorporation of GPP and GSCP as a natural preservative improved the physico-chemical, proximate and sensory properties of the spent hen meat nuggets. GPP and GSCP contain

various antimicrobial and antioxidant component which help to extend the shelf life of product. Chicken nuggets could be conveniently packed in LDPE for a period of 20 days in refrigerated ( $4 \pm 1^\circ\text{C}$ ) condition. Results of the above study suggested that nuggets incorporated with GPP and GSCP from spent hen meat were highly acceptable.

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