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Effect of Gooseberry Pulp and Seed Coat Powder as Natural Preservatives on the Storage Quality of Chicken Nuggets

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ABSTRACT

The present study was aimed to investigate the effects of Gooseberry pulp powder (GPP) and Gooseberry seed coat powder (GSCP) treatment on the quality attributes of vacuum packaged spent hen meat nuggets stored at 4±1°C for 25 days. On the basis of preliminary trials and relevant literature, three different levels of incorporation i.e. 0.5%, 1% and 1.5% were incorporated in chicken nuggets formulation replacing lean meat and samples were evaluated for physico-chemical, microbial, proximate and sensory qualities at periodic interval of 5 days. Vacuum packaging in combination with GPP and GSCP treatment had significantly ($P<0.05$) inhibited lipid oxidation in spent hen meat nuggets. The treated samples exhibited significantly ($P<0.05$) low total plate count, pyschrophilic, yeast and mould, coliform count as compared to control. Based on sensory evaluation, at the end of storage study on 25th day 0.5% GPP added nuggets exhibited higher overall acceptability than other samples. It can be concluded that GPP, GSCP and vacuum packaging have a potential for development of functional spent hen meat nuggets.

HIGHLIGHTS

- GPP and GSCP had potential source of natural preservative which can be successfully used as antimicrobial agent for chicken nuggets.
- In respect to microbial quality and sensory attributes of treated samples were significantly ($P<0.05$) low compared to control.
- Lipid oxidation of products were increased ($p>0.05$) but control showed highest values compared to treatments at the end of storage study.

Keywords: Gooseberry pulp powder, Seed coat powder, Chicken nuggets, Vacuum packaging, Storage stability

Chicken is second highest consumed meat worldwide because of its high nutritional and organoleptic properties over red meat. This meat is considered as nutrient dense food, valuable in planning healthy diets. Poultry industry stood second after pork in all over the world. India ranks 5th in the world for broiler and 3rd in egg production with an annual growth rate in the range of 6-8% (DADF., 2017). The price of unit chicken is lower than mutton or chevon and top of it, this meat is free from all religious taboos (Singh *et al*., 2014; Kumar *et al*., 2015). Spent hen meat which are ponder as lower quality meat for its higher toughness, less juiciness, high collagen content and high degree of cross linkages as contrast to broiler (Goswami *et al*., 2019). As a result, farmers does not get remunerative prices, also consumers do not prefer such meat. Thus, proper disposal of these fowl is a real problem for traders.

In recent times, consumers become more concern about the inventible influence of diet on health and well-being.

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Various types of plant or fruit based by-products are included in our routine diet (Balanced diet). Gooseberry have several beneficial effects such as hypolipidemic, expectorant, purgative, spasmolytic, antibacterial, hypoglycaemic, hepatoprotective, hypolipidemic, etc. (Liu *et al*., 2012). This fruit also contain several beneficial compounds effective against pathogens like *Escherichia coli, Staphylococcus aureus, Klebsiella pneumonia, Pasteurella multocida, Streptococcus pyogenes, Pseudomonas aeruginosa* (Javale *et al*., 2010; Mehrotra *et al*., 2010). Usually, gooseberry seed coat is discarded as waste after utilization the fruit. This coat is a rich source of several beneficial compounds and has been reported to have high water holding capacity and swelling capacity (9.50 g water/g and 12.86 ml water/g respectively, on dry weight basis) than the seed powder (Goswami *et al*., 2017).

Now-a-days changes occurring in consumer's lifestyle as well as in eating habits shifted the liking of consumer from fresh meat to processed meat product. Thus, use of gooseberry pulp and seed coat as an additive in nuggets preparation, is a challenge for its economic formulation and production keeping the sensory attributes to an acceptable level.

MATERIALS AND METHODS

Procurement of raw materials, chemicals and media

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

Preparation of chicken nuggets

Chicken nuggets were prepared as per Verma *et al.* (2012) with slight modifications as per Table 1.

Sensory attributes of 0.5% GPP, 1.5% GSCP added chicken nuggets most comparable to control, which was vacuum packaged in Metalize Polyethylene terephthalate (MET-PET) pouches and stored at refrigerated temperature (4±1ºC). The quality changes in the nuggets were evaluated after drawing sample at regular intervals of 0, 5, 10, 15, 20 and 25 days of storage.

Physico-chemical parameters

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 and moisture, protein, fat (ether extract), crude fibre and total ash were determined.

Table 1: Formulation of chicken nuggets from the meat of spent hen

Ingredient percent (w/w)	Control (%)	0.5 (%) Pulp	1.5(%) Seed coat
Lean meat	68.00	67.5	66.5
Added water	10.00	10.00	10.00
Vegetable oil	9.00	9.00	9.00
Condiment mix	5.00	5.00	5.00
Refined wheat flour	4.00	4.00	4.00
Spice mixture	2.00	2.00	2.00
Table salt	1.70	1.70	1.70
Sodium Tripolyphosphate	0.30	0.30	0.30
Gooseberry pulp powder	—	0.5 %	—
Gooseberry Seed coat powder	—	—	1.5 %

TBARS number

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

Microbiological analysis

The prepared nuggets were subjected to microbial analysis for determination of total plate count, coliform count, yeast and mould count; psychrophilic counts by following methods as per American Public Health Association (APHA, 1992).

Sensory evaluation

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 experienced panellists.

STATISTICAL ANALYSIS

Statistical analysis of the data obtained was carried out as per the methods described by Snedecor and Cochran (1994). The whole experiment was repeated three time and analysed in duplicate and results were expressed as Mean+ SE. The level of significant was at $p<0.005$.

RESULTS AND DISCUSSION

Proximate parameters

The proximate parameters of chicken nuggets incorporated with GPP and GSCP are presented in Table 2. The moisture values of all samples recorded a significantly increase during the storage study but the GSCP added nuggets showed highest value for moisture compared to the others. GSCP incorporated nuggets were highest moisture. It might be due to seed coat powder showed higher water

Table 2: Proximate composition of chicken nuggets (mean ± S.E) incorporated with GPP and GSCP under vacuum packaging condition stored at refrigeration temperature (4±1°C)

Treatments	0 day	5 day	10 day	15 day	20 day	25 day
			Moisture (%)			
Control	63.24 ± 0.01^{aA}	63.28 ± 0.02^{bA}	63.30 ± 0.02^{bA}	63.39 ± 0.05^{cA}	63.44 ± 0.01^{dA}	63.47 ± 0.07^{dA}
0.5 % GPP	63.34 ± 0.07^{aB}	63.36 ± 0.01^{aB}	63.41 ± 0.01^{bB}	64.52 ± 0.09^{cB}	64.56 ± 0.01^{dB}	64.59 ± 0.05^{dB}
1.5 % GSCP	64.42 ± 0.07^{aC}	64.43 ± 0.01^{aC}	64.45 ± 0.01^{abC}	64.48 ± 0.02^{bC}	64.57 ± 0.01^{cC}	64.60 ± 0.07^{cC}
			Protein (%)			
Control	18.84 ± 0.08^{aA}	18.80 ± 0.04^{bA}	18.82 ± 0.05^{abA}	18.77 ± 0.09^{cA}	18.70 ± 0.1^{dA}	18.72 ± 0.07^{deA}
0.5 % GPP	18.73 ± 0.09^{aB}	18.68 ± 0.09^{bB}	18.71 ± 0.05^{acB}	18.65 ± 0.03^{dB}	18.59 ± 0.04^{eB}	18.55 ± 0.01^{fB}
1.5 % GSCP	18.64 ± 0.06^{aC}	18.59 ± 0.05^{bC}	18.62 ± 0.05^{aC}	18.56 ± 0.06^{cC}	18.43 ± 0.05^{dC}	18.47 ± 0.05^{eC}
			Fat (%)			
Control	14.63 ± 0.08^{aA}	14.61 ± 0.06^{aA}	14.64 ± 0.03^{cA}	14.62 ± 0.05^{aA}	14.60 ± 0.06^{bA}	14.63 ± 0.05^{cA}
0.5 % GPP	14.22 ± 0.07^{aB}	14.23 ± 0.06^{aB}	14.25 ± 0.04^{cB}	14.22 ± 0.06^{aB}	14.25 ± 0.05^{bcB}	14.25 ± 0.06^{bcB}
1.5 % GSCP	14.12 ± 0.08^{aC}	14.11 ± 0.2^{abC}	14.12 ± 0.08^{abC}	14.15 ± 0.05^{cC}	14.10 ± 0.05^{aC}	14.13 ± 0.06^{bcC}
			Total Ash (%)			
Control	2.40 ± 0.08^{aA}	2.39 ± 0.06^{abA}	2.35 ± 0.05^{dA}	2.37 ± 0.08^{bA}	2.33 ± 0.08^{dA}	2.33 ± 0.09^{eA}
0.5 % GPP	2.57 ± 0.06^{aB}	2.57 ± 0.06^{abB}	2.52 ± 0.04^{cB}	2.55 ± 0.09^{bB}	2.51 ± 0.01^{cB}	2.50 ± 0.06^{cB}
1.5 % GSCP	2.47 ± 0.08^{aC}	2.46 ± 0.06^{aC}	2.42 ± 0.05^{bcC}	2.43 ± 0.05^{bC}	2.42 ± 0.06^{bcC}	2.4 ± 0.08^{cdC}
			Crude fibre (%)			
Control	0.58 ± 0.05^{aA}	0.59 ± 0.06^{abA}	0.61 ± 0.05^{cA}	0.59 ± 0.03^{abA}	0.6 ± 0.08^{bcA}	0.58 ± 0.05^{afA}
0.5% GPP	0.74 ± 0.04^{abB}	0.75 ± 0.03^{bcB}	0.73 ± 0.05^{aB}	0.78 ± 0.06^{dB}	0.76 ± 0.04^{cB}	0.75 ± 0.06^{bcB}
1.5% GSCP	0.84 ± 0.07^{aC}	0.85 ± 0.05^{abC}	0.86 ± 0.03^{cC}	0.89 ± 0.01^{dC}	0.91 ± 0.03^{eC}	0.92 ± 0.08^{eC}

Mean ± S.E with different small letter superscripts in rows and capital letter superscript in columns within each parameter differ significantly ($p\leq0.05$). Control-chicken nuggets without GPP and GSCP, GPP- gooseberry pulp powder, GSCP- gooseberry seed coat powder.

holding capacity and swelling capacity with mean value of 9.5 g water/g and 12.86 mL water/g, respectively on dry matter basis (Goswami *et al*., 2017). Das *et al.* (2013) reported significantly higher ($p<0.01$) contents of moisture, was recorded in treated nuggets as compared to the control product. Fernandes-gines *et al.* (2004) reported cooked lamon albedo fibres (2.5-5%) in bolongas sausages showed higher moisture content than control. In contrast to above results Kenawoi (2003) found that loss of moisture content was not significant ($P>0.05$) in vacuum packaged samples and Reshi *et al.* (2017) reported in ginger extract treated sausage and control values shows higher moisture value compared to control but as the storage period increased moisture level significantly ($P>0.05$) decreased in all samples.

Control nuggets showed highest value for protein and fat content during entire storage period as compared to the GPP and GSCP incorporated nuggets. Protein and fat values were decreased significantly ($p\leq0.05$) during entire storage period. The lower protein and fat content of treatment groups might due to replacement of lean meat by gooseberry pulp and gooseberry seed coat which is low in protein and ether extract content. Polizer *et al.* (2015) reported partial replace of fat by pea fiber in chicken nuggets and noted high fat content (14.32 %). Zagar *et al.* (2014) also reported similar findings with decrease the protein and fat level in chicken sausage with increased pumpkin levels. GPP nuggets showed highest value for total ash and GSCP showed highest value for crude fibre during entire storage period and no significant change ($p\leq0.05$) observed during whole storage period. In case of total ash results were in agreement with above Das *et al.* (2013) found that fermented bamboo shoot incorporated in chicken nuggets were registered of significantly higher ($p<0.01$) total ash and crude fibre content in treated products as compared to the control.

Table 3: Physico-chemical and microbial parameters of chicken nuggets incorporated with GPP and GSCP under vacuum packaging condition stored at refrigeration temperature (4±1 °C) (mean ± S.E)

Treatments	0 day	5 day	10 day	15 day	20 day	25 day
pH						
Control	6.16 ± 0.09^{Aa}	6.21 ± 0.06^{bA}	6.24 ± 0.05^{cA}	6.33 ± 0.06^{dA}	6.42 ± 0.05^{eA}	6.54 ± 0.07^{Fa}
0.5 % GPP	6.03 ± 0.08^{Ab}	6.05 ± 0.08^{bB}	6.09 ± 0.07^{cB}	6.14 ± 0.06^{dB}	6.22 ± 0.09^{eB}	6.33 ± 0.06^{Fb}
1.5% GSCP	6.09 ± 0.07^{aC}	6.11 ± 0.44^{abC}	6.16 ± 0.06^{cC}	6.21 ± 0.05^{dC}	6.34 ± 0.03^{eC}	6.48 ± 0.05^{Fc}
TBA values (mg malonaldehyde/kg)						
Control	0.37 ± 0.07^{aA}	0.39 ± 0.05^{bA}	0.51 ± 0.03^{cA}	0.61 ± 0.06^{dA}	0.77 ± 0.08^{eA}	0.93 ± 0.07^{Fa}
0.5 % GPP	0.21 ± 0.04^{Ab}	0.25 ± 0.05^{bB}	0.31 ± 0.05^{cB}	0.39 ± 0.05^{dB}	0.56 ± 0.06^{eB}	0.75 ± 0.04^{Fb}
1.5% GSCP	0.26 ± 0.05^{Ac}	0.30 ± 0.05^{bC}	0.41 ± 0.05^{cC}	0.52 ± 0.06^{dC}	0.72 ± 0.07^{eC}	0.86 ± 0.06^{Fc}
Total Plate Count (Log_{10} CFU/g/)						
Control	1.92 ± 0.07^{a}	2.04 ± 0.05^{b}	2.27 ± 0.03^{cA}	3.04 ± 0.05^{dA}	4.08 ± 0.06^{eA}	4.78 ± 0.06^{Fa}
0.5 % GPP	1.70 ± 0.07^{a}	1.76 ± 0.06^{b}	1.88 ± 0.04^{cB}	2.25 ± 0.02^{dB}	3.28 ± 0.03^{eB}	4.02 ± 0.04^{Fb}
1.5% GSCP	1.82 ± 0.05^{a}	1.88 ± 0.09^{b}	1.98 ± 0.03^{cC}	2.58 ± 0.07^{dC}	3.66 ± 0.05^{eC}	4.50 ± 0.07^{Fc}
Psychrophilic count (Log_{10} CFU/g/)						
Control	N.F	1.51 ± 0.05^{a}	$1.58.\pm0.05^{bA}$	1.68 ± 0.05^{cA}	2.92 ± 0.06^{dA}	3.58 ± 0.06^{Ea}
0.5 % GPP	N.F	1.29 ± 0.04^{a}	1.36 ± 0.05^{bB}	1.46 ± 0.05^{cB}	2.44 ± 0.05^{dB}	3.14 ± 0.04^{Eb}
1.5% GSCP	N.F	1.36 ± 0.06^{a}	1.47 ± 0.05^{bC}	1.54 ± 0.03^{cC}	2.68 ± 0.05^{dC}	3.22 ± 0.05^{Ec}
Yeast and mould count (Log_{10} CFU/g/)						
Control	NF	1.35 ± 0.05^{a}	1.49 ± 0.05^{bA}	1.61 ± 0.06^{cA}	2.39 ± 0.06^{dA}	3.28 ± 0.05^{Ea}
0.5 % GPP	NF	1.20 ± 0.07^{a}	1.28 ± 0.09^{bB}	1.36 ± 0.05^{cB}	1.90 ± 0.07^{dB}	2.45 ± 0.05^{Eb}
1.5% GSCP	NF	1.26 ± 0.05^{a}	1.37 ± 0.05^{bC}	1.44 ± 0.05^{cC}	2.16 ± 0.05^{dC}	2.86 ± 0.05^{Ec}

Mean ± S.E with different small letter superscripts in rows and capital letter superscripts in columns within each parameter differ in rows and capital letter superscripts in columns within each parameter differ significantly ($p\leq0.05$); n=6. significantly ($p\leq0.05$); n=6, NF-Not found, ND-Note done. Control-chicken nuggets without GPP and GSCP, GPP- gooseberry pulp powder, GSCP- gooseberry seed coat powder.

Physico-chemical and microbial parameters

Various physico-chemical and microbial parameters of chicken nuggets incorporated with GPP and GSCP are presented in Table 3. TBA and pH values in nuggets showed significantly ($P<0.05$) increasing trend with advancement of storage period. TBA and pH showed the lowest value for 0.5 % GPP added nuggets during the entire storage period as compared to the control and GSCP incorporated nuggets in vacuum packaging. During the entire storage period, an increasing in pH value was observed. It might be due to the production of volatile base compounds by bacterial activity which develop under the microaerophilic environment. Decrease levels of pH might be attributed to increased solubility of carbon dioxide at storage time leading to decreased growth of aerobic microflora (Viji *et al*., 2016). Results of the above finding were a comparable with the findings by Erkan *et al*. (2011) for plant extract added and vacuum-packed smoked rainbow trout during chill storage. In contrast to above results Sinhamahapatra *et al*. (2013) reported that pH of meat ball increased during vacuum packaged during refrigerated storage.

During the storage period, there were a significant increase in total plate count (TPC), psychrophilic count, yeast and mold count (log 10 cfu/gm) in all samples. It might be due to the antimicrobial effect of GPP and GSCP powder and vacuum packaging. At 25th days of storage, control nuggets showed the highest value than treatment samples. psychrophilic and yeast and mold count were not detected on the 0thday of storage in vacuum packaging. Coliforms were not detected in any samples during the entire period of storage. Similar increase in TPC during storage was reported by Bali *et al*. (2011) in garlic and coriander incorporated chicken sausage, Bariya *et al*. (2016) in gooseberry fruit and seed coat extract incorporated goat meat patties, Giriprasad *et al*. (2015) in restructured buffalo meat steaks added with mousambi peel powder and amla powder, Babji *et al*. (2000) reported that aerobic packaged minced goat meat had higher yeast and mold count than vacuum packaged minced goat meat under refrigeration during 28 days of storage.

Table 4: Sensory attributes of chicken nuggets chicken nuggets incorporated with GPP and GSCP under vacuum packaging condition stored at refrigeration temperature (4±1^{o}C) (mean ± S.E)

Treatments	0 day	5 day	10 day	15 day	20 day	25 day
Colour and appearance						
Control	7.50±0.03^{aA}	7.40±0.05^{abB}	7.20±0.05^{cA}	6.90±0.05^{dA}	6.60±0.07^{eA}	5.10±0.08^{Fa}
0.5 % GPP	7.30±0.03^{abcB}	7.25±0.06^{abcB}	7.13±0.04^{cdB}	7.01±0.01^{deB}	6.95±0.01^{eB}	6.70±0.09^{Fb}
1.5% GSCP	7.28±0.04^{abB}	7.22±0.02^{abcB}	7.09±0.03^{cdB}	6.95±0.04^{efA}	6.83±0.03^{fB}	6.30±0.09^{Gc}
Flavour						
Control	7.39±0.01^{aA}	7.28±0.01^{bA}	7.16±0.04^{cA}	6.98±0.02^{dA}	6.85±0.07^{eA}	5.60±0.03^{FaB}
0.5 % GPP	7.35±0.03^{abA}	7.32±0.01^{abA}	7.17±0.02^{cA}	7.00±0.02^{dA}	6.79±0.01^{eA}	6.45±0.08^{FbA}
1.5% GSCP	7.20±0.06^{aB}	7.14±0.03^{abB}	7.03±0.02^{cB}	6.89±0.03^{dB}	6.81±0.02^{deB}	6.30±0.04^{FcA}
Juiciness						
Control	7.20±0.07^{aA}	7.15±0.05^{abA}	7.08±0.04^{cA}	6.95±0.05^{dA}	6.87±0.07^{eA}	5.63±0.07^{efB}
0.5 % GPP	7.24±0.09^{aA}	7.20±0.05^{abB}	7.14±0.05^{bcA}	7.08±0.04^{dB}	6.92±0.07^{eA}	6.88±0.05^{efA}
1.5% GSCP	7.32±0.06^{aB}	7.28±0.06^{abB}	7.20±0.04^{bcB}	7.11±0.05^{dB}	6.98±0.01^{eB}	6.84±0.01^{FaA}
Texture						
Control	7.22±0.01^{aA}	7.16±0.01^{abA}	7.05±0.04^{cA}	6.92±0.04^{dA}	6.72±0.02^{eA}	5.90±0.03^{Fa}
0.5 % GPP	7.28±0.02^{aA}	7.20±0.01^{bA}	7.12±0.03^{cA}	7.0±0.03^{dA}	6.85±0.03^{eB}	6.60±0.05^{Fb}
1.5% GSCP	7.32±0.03^{aB}	7.22±0.03^{bB}	7.12±0.01^{cA}	6.96±0.02^{dA}	6.88±0.02^{deB}	6.78±0.01^{Fc}
Overall acceptability						
Control	7.35±0.04^{aA}	7.28±0.02^{abA}	7.17±0.02^{cA}	7.06±0.09^{cdA}	6.95±0.04^{deA}	5.82±0.05^{Fa}
0.5 % GPP	7.20±0.04^{aB}	7.15±0.02^{abB}	7.06±0.06^{bcA}	6.95±0.05^{cdA}	6.90±0.02^{deA}	6.76±0.02^{Fb}
1.5% GSCP	7.12±0.03^{aB}	7.06±0.02^{abB}	6.97±0.03^{bcB}	6.93±0.01^{cdB}	6.82±0.03^{deB}	6.56±0.09^{Fb}

Mean ± S.E with different small letter superscripts in rows and capital letter superscripts in columns within each parameter differ in rows and capital letter superscripts in columns within each parameter differ significantly ($p\leq0.05$); n=6. significantly ($p\leq0.05$); n=6, Control-chicken nuggets without GPP and GSCP, GPP- gooseberry pulp powder, GSCP- gooseberry seed coat powder

Psychrophilic count was observed from day 5th day of the storage in treated products as well as control. This could be due to the destruction of psychrophiles during cooking. An increase in the psychrophilic count during vacuum storage had also been reported by Malav *et al*. (2012) in restructured chicken meat blocks. After that on the 15th day of storage psychrophilic count for both the treatments were significantly higher (P<0.05) than control. Similar findings were also reported by Singh *et al.* (2014) incorporated clove oil incorporated chevon cutlets, Kumar *et al.* (2018) in sapota powder added pork patties, Najeeb *et al*. (2014) mixed fruits powder in restructured chicken slices, Kantale *et al*. (2019) in spent hen meat slices and Goswami *et al.* (2019) in chicken nuggets.

Sensory attributes

The results depicting for colour and appearance, juiciness, flavour, texture and overall acceptability of vacuum packaged chicken nuggets were presented in Table 4. The effect of storage period and treatment on sensory characteristics of nuggets were found to be highly significant (P<0.05). Control samples were recorded with higher sensory score than both treated nuggets up to 10th days. Results exhibited a significantly liner decline in all sensory characteristics score were observed as storage period advanced. At the 25th day 0.5% pulp added nuggets showed higher sensory characteristics score than all other samples. A similar decline in all sensory attributes during storage had been reported by Sinhamahapatra *et al*. (2013) in meatballs, Zargar *et al.* (2014) in chicken sausage, Singh *et al*. (2014) in fibre enriched chevon cutlets, Giriprasad *et al.* (2015) in restructured buffalo meat steaks added with mousambi peel powder and amla powder, Najeeb *et al*. (2014) added fruits powder (red grapes, gooseberry and tomato) in restructured chicken slices and Goswami *et al.* (2019) also observed that as the storage day advanced decreasing trends in sensory attributes score were observed.

CONCLUSION

Thus GPP and GSCP had potential source of natural preservative which can be successfully used as antimicrobial agent for chicken nuggets. These observations concluded that the 0.5% GPP and 1.5% GSCP added chicken nuggets can be stored in vacuum packaged MET-PET pouches for 25 days without marked deterioration in physicochemical, microbiological and sensory characteristics at refrigerated storage. So, these GPP and GSCP could be one of the best natural preservative in food industry for development of low cost processed meat products.

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