Storage Stability of Vacuum Packaged Traditional Pork Product Incorporated with Silam (*Perilla frutescens* [L] *Briton*) Seeds at Refrigeration Temperature (4±1°C)

H. M. Sangtam a, S. K. Laskar b*, A. Das b, P. Gogoi b, S. Choudhury b and A. Mali b

a ICAR-Krishi Vigyan Kendra, Wokha 797111, India.  
b Department of Livestock Products Technology, College of Veterinary Science, AAU, Khanapara, Guwahati-22, India.

Authors’ contributions

This work was carried out in collaboration among all authors. Author HMS designed the study and wrote the first draft of the manuscript. Author SKL managed the analyses of the study and finalized the manuscript. Author AD managed the literature searches. Author PG performed the statistical analysis. Author SC arranged the data for statistical analysis. Author AM arranged and conducted the sensory evaluation of the product. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2023/v42i184142

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/100947

Received: 27/04/2023  
Accepted: 29/06/2023  
Published: 10/07/2023

ABSTRACT

The present study was conducted to investigate the effect of vacuum packaging on the physicochemical, microbial and sensory properties of ready-to-eat pork curry with silam (*Perilla frutescens* [L] *Britton*) seeds, a traditional cuisine from Nagaland. The parameters were studied at...
Due to improvement of economic condition and rise in living standards of the people, the preferences of traditional pork products has been gaining popularity and are in high demand in various markets in Nagaland. The countrywide increasing demand of Naga style cooked pork and pork products have resulted in opening of numbers of restaurants serving Naga cuisine in different cities of the country.

2. MATERIALS AND METHODS

2.1 Source of Raw Material

The ham portion of Hampshire and Ghungroo cross breed pig of 8-10 months old was procured from the ICAR-NRC on pig-Rani. The meat was packed in LDPE packs and frozen in small unit packs of 1 kg each and stored in deep freezer (-18°C) until use. The required portion of the frozen meat for the experiment was taken out and kept at refrigeration temperature (4±1°C) overnight for thawing and subsequently used. After separation of fat and skin, deboning of lean meat was done manually maintaining hygienic condition in the laboratory. The meat was cut into 2 cm cubes and use for further processing.

Following condiments and vegetables were selected viz. onion, garlic, ginger, tomato and fresh green chilies which were procured from local market and paste were prepared in the laboratory for further use. The Silam seeds were cleaned thoroughly for removal of any extraneous matters. The seeds were then dried in the oven at 60°C for 10 minutes and grounded to make a paste.

2.2 Product Formulation and Product Preparation

The formula for traditional pork product incorporated with Silam was developed after conducting a series of preliminary trails. The

Keywords: Silam; traditional; vacuum packaging; quality.
product formulation consisted of 55% pork, non-meat ingredients traditional ingredient Silam paste 10%, salt 1.5%, ginger 2%, green chillies 4%, tomato 3%, condiments (onion and garlic 4:1) 4.5% and portable water 30%. The lean meat was mixed thoroughly with Silam paste, fresh green chilies, tomato, onion, garlic, ginger, salt and water in a bowl and pressure cooked for 20 minutes. The quantity of product in each package was 200g (120g meat and 80g gravy) and the packages were kept under refrigerated temperature (4±1°C) maintaining their identity. The samples were assessed at 0, 5, 10 and 15 day for shelf life stability and other quality parameters.

2.3 Packaging

Vacuum packaging was done in vacuum packaging machine Sevana’s (Sevol V, Model No. Q5S00VMG-MC) packaging machine and the products were packed in High Density Polyethylene (HDPE) packaging material.

2.4 Analytical Procedures

2.4.1 Physicochemical analysis

The proximate composition of the Silam incorporated pork product including moisture, crude protein, ether extract and total ash was determined using AOAC [7] methods.

The pH of the samples was determined as per the method of Pippen et al. [8] by using a digital pH meter (Make: Metrohm, Switzerland; Model: 780). Fifteen grams of the samples were blended with 30 ml of distilled water, and the homogenate was poured through Whatman No. 1 filter paper. The filtrate obtained was used to measure the pH using the digital pH meter. The TBA value was determined as per the method of Witte et al. [9]. The tyrosine value was determined as described by Strange et al. [10].

2.4.2 Microbiological quality

2.4.2.1 Total Viable Count (TVC)

“Enumeration of the total viable plate count of the pork product samples was done in standard plate count agar medium by following the pour plate technique as described” by APHA [11].

2.4.2.2 Total Viable Psychrophilic Bacterial Count (TVBC)

“The Total Viable Psychrophilic Bacterial Counts of “pork with Anishi” were determined by the procedure described” by the APHA [11].

2.4.2.3 Coliform count

Coliform counts were enumerated by following standard techniques [12]. It was done by inoculating 1ml of the diluents in Endo agar followed by incubating at 37°C for 24h. The average number of colonies counted was then expressed as the presence or absence of coliforms in samples.

2.4.2.4 Yeast and mould counts

“Yeast and mould counts of the samples were made at similar time intervals as the total plate count by inoculating the appropriate dilution of the sample on Rose Bengal Agar Base and incubating at 37°C up to 72h” [12].

2.4.3 Shelf-life study

Shelf-life studies were conducted based on microbiological quality, proximate analysis, TBARS value, tyrosine value and sensory evaluation of the products. The maximum shelf life was assured as soon as the products exceeded the microbial load of 10⁵/g. Simultaneously, TBA values and other physical changes like the development of off-odour, sliminess, and discolouration of the product were recorded.

2.4.4 Sensory evaluation

“The traditional pork curries with different levels of silam were evaluated for organoleptic qualities by serving the products to a 7-member panel of semi-trained judges of different age groups and sexes. All the samples were evaluated for appearance, flavour, juiciness, tenderness and overall acceptability using a 7-points hedonic scale score card as described” by Ingham et al. [13].

2.5 Statistical Analysis

The results were analyzed statistically following the standard statistical method as described by Snedecor and Cochran [14] and the calculation by using SAS version-9.2.
3. RESULTS AND DISCUSSION

3.1 Changes in Physicochemical Characteristics

The mean values for physicochemical characteristics of traditional pork incorporated with Silam during refrigerated storage are presented in Table 1. The overall mean values for different days of storage, showed a significant (p<0.01) decline in pH with increasing storage period up to 15 days. Incze [15] reported that decrease in the pH values might be due to significant (p<0.05) increase in microbial count during storage period producing lactic acid by breakdown of carbohydrates. Moisture content values decreased gradually during the entire period of storage. However no significant difference was observed in the treated product under vacuum packaging. Anandh [16] also reported that decreased in moisture content was observed in boiled restructured buffalo meat rolls in refrigerated storage under vacuum packaging condition during 0 to 30 day of refrigerated storage. Maca et al. [17] reported first decrease and then increase in the moisture content and opined that it might be due to break down of protein which releases water at later stage. The ether extract percent revealed highly significant (p<0.01) differences in the traditional pork products under vacuum packaging at refrigerated storage. The decrease in moisture content in the products during storage might have attributed to the increase in the ether extract content of the products.

There was highly significant (p<0.01) difference in total ash content of the vacuum packaged products during different storage days. However, on 0 day of storage period the ash content of higher than the 15 day. Akhter et al. [18] who also observed decreasing trend in ash content during storage of dried preservation technique on nutrient content of beef. Significant difference (p<0.01) in protein content between control and treated products were observed with increasing levels of silam, which may be due to lower protein content of silam that replaced the lean pork in successive treatment formulations. Decreasing trend in percent of protein was observed in the products during the storage period under vacuum packaging. However, the total ash content was higher in 0 day and lower content was observed on 10 day of storage period. Ockerman [19] reported that as the moisture content of meat increased, protein and dry matter contents decreased reciprocally.

Another reason might be due to breakdown of protein during storage of the products due to enzymatic action of microbes. The TBARS value was observed with increase in storage period. However the values remained well within the threshold limit of 1-2 mg malonaldehyde/kg of the pork product during the entire storage period under vacuum packaging. The increase in TBARS values during storage might be attributed to the oxidation of meat lipid under refrigerated storage. A positive correlation between microbial load and TBA value was reported by Sudheer et al. [20]. "A significant (p<0.01) and progressive increase in TBA value was observed with increase in storage period. Increase of microbial load in meat samples could have caused increased oxidative changes. These changes might be attributed to increase in TBA value" [21]. The increasing trends of tyrosine values were observed in the product during storage period under vacuum packaged refrigerated storage. The findings are in agreement with the statement of Pearson [22] who reported “the increased tyrosine value in beef during storage due to the formation of free amino acids from denaturation process". Lalchamliani et al. [23] reported similar results in Vawksa rep samples stored under different aerobic vacuum packaging condition at 4±1°C. Anandh [16] also reported that “tyrosine values increase on vacuum packaged, boiled restructured buffalo meat rolls during refrigerator storage (4±1°C)*.

3.2 Changes in Microbial Quality

The mean values for microbial profile of pork with Silam during refrigerated storage are presented in Table 2. TPCs and Psychrophilic count were increased significantly (p<0.01) with increasing storage period. However, the product did not show any symptoms of spoilage such as off odour and surface slime on day 15 of storage.

“During the storage period, microbiological counts were well below the standards for cooked products” [21]. Kumar et al. [24] reported “gradual but significant increase in total viable counts throughout the storage period in pork nuggets”. “Increases of microbial counts were also observed in meat products as the refrigerated storage advanced” [25]. The low microbial counts of present study were in accordance with Sinhamahapatra et al. [26] on vacuum-packed chicken meat balls and Anandh [16] in boiled restructured buffalo meat rolls in
refrigerated storage under vacuum packaging condition. The coliform count were less than 3 (<3) in all the storage period of vacuum packaging. However, yeast and mould count were not detected during the entire storage period of vacuum packaged pork product.

### 3.3 Changes in Sensory Attributes

The mean values for sensory attributes of pork with *Silam* during refrigerated storage are presented in Table 3. The sensory attributes like appearance, flavour, juiciness, tenderness and overall acceptability scores were decreased with increasing storage period.

**Table 1. Changes in physicochemical characteristics of vacuum-packaged, pork curry with *Silam* during refrigeration storage (4±1°C)**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean±SE of different days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>a68.97±0.86 &amp; 68.33±0.89 &amp;  68.45±0.86 &amp;  68.31±0.27</td>
</tr>
<tr>
<td>Ether extract (%)</td>
<td>b8.03±0.79 &amp;  8.19±0.38 &amp;  ab9.43±0.34 &amp;  a10.04±0.29</td>
</tr>
<tr>
<td>Total Ash (%)</td>
<td>a6.29±0.13 &amp;  6.19±0.34 &amp;  a6.11±0.34 &amp;  a5.55±0.11</td>
</tr>
<tr>
<td>Crude Protein (%)</td>
<td>a16.01±0.16 &amp;  15.02±0.26 &amp;  b14.76±0.25 &amp;  b14.81±0.33</td>
</tr>
<tr>
<td>pH</td>
<td>a5.89±0.01 &amp;  5.90±0.03 &amp;  ab5.62±0.09 &amp;  a5.52±0.15</td>
</tr>
<tr>
<td>TBARS value</td>
<td>a0.65±0.03 &amp;  a0.88±0.11 &amp;  a1.21±0.05 &amp;  a1.38±0.02</td>
</tr>
<tr>
<td>Tyrosine value</td>
<td>a58.00±0.25 &amp;  58.47±0.29 &amp;  a58.74±0.18 &amp;  c73.39±0.59</td>
</tr>
</tbody>
</table>

Means having different superscript in column (capital letter) differ significantly (p<0.01) for different products on different days.

Means having different superscript in row (small letter) differ significantly (p<0.01) between days of different products.

**SE= Standard Error, n=5**

**Table 2. Changes in microbial profile of vacuum-packaged pork curry with *silam* during refrigeration storage (4±1°C)**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean±SE of different days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>TPC (cfu/g)</td>
<td>a1.98±0.05 &amp;  b2.27±0.02 &amp;  b2.58±0.05 &amp;  c3.21±0.24</td>
</tr>
<tr>
<td>Psychrophilic Count (cfu/g)</td>
<td>a1.78±0.11 &amp;  b2.08±0.03 &amp;  a2.32±0.02 &amp;  a2.56±0.03</td>
</tr>
<tr>
<td>Coliform Count (MPN/g)</td>
<td>&lt;3 &amp; &lt;3 &amp; &lt;3 &amp; &lt;3</td>
</tr>
<tr>
<td>Yeast and Mould Count (cfu/g)</td>
<td>ND &amp; ND &amp; ND &amp; ND</td>
</tr>
</tbody>
</table>

**Table 3. Changes in sensory characteristics of vacuum-packaged pork curry with *silam* during refrigeration storage (4±1°C)**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean±SE of different days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Appearance</td>
<td>a6.60±0.08 &amp;  6.11±0.05 &amp;  6.17±0.06 &amp;  6.00±0.00</td>
</tr>
<tr>
<td>Flavour</td>
<td>a6.74±0.07 &amp;  6.34±0.08 &amp;  b6.23±0.07 &amp;  a6.11±0.05</td>
</tr>
<tr>
<td>Juiciness</td>
<td>a6.94±0.04 &amp;  6.20±0.07 &amp;  6.11±0.05 &amp;  b6.43±0.08</td>
</tr>
<tr>
<td>Tenderness</td>
<td>a7.00±0.00 &amp;  6.29±0.08 &amp;  bc6.17±0.06 &amp;  a6.11±0.05</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>a7.00±0.00 &amp;  6.14±0.06 &amp;  bc6.06±0.04 &amp;  a6.00±0.00</td>
</tr>
</tbody>
</table>

**Mean having different superscript in column (capital letter) differ significantly (p<0.01) for different products on different days.**

Mean having different superscript in row (small letter) differ significantly (p<0.01) between days of different products.

SE= Standard Error, n=5

*Sensory attributes were evaluated on 7-point hedonic scale (where 1 = undesirable and 7 = very desirable)*
4. CONCLUSION

The study concluded that vacuum packaging had definite advantage in preserving the sensory and microbial quality of traditional pork product incorporated with Silam. The pork with Silam had better acceptability up to 15 days of storage at 4±1°C in HDPE pouches under vacuum packaging condition.

ACKNOWLEDGEMENTS

The authors acknowledge the support of the All India Coordinated Research Project on Post-Harvest Engineering and Technology, Indian Council of Agricultural Research, Khanapara centre for providing laboratory support to carry out the present research work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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The Ohio State University and the Ohio Agricultural Research and Development Centre, Columbus and Wooster, Ohio, USA; 1985.


