***Original Research Article***

# Storage stability of vacuum packaged traditional pork product incorporated with *Silam* (*Perilla frutescens* [L] *Briton*) seeds at refrigeration temperature (4±1$^{o}$C)


**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 regular intervals of 0, 5, 10 and 15 days with refrigerated storage at (4 ±1 °C). A significant ($p<0.01$) decrease in pH, moisture and crude protein was observed with increasing storage time. A significant ($p<0.01$) increase in TBARS and tyrosine levels was observed with increasing storage time. The microbiological numbers increased with increasing storage time. However, throughout the storage period, all bacterial counts were within the acceptable limits of pork curry with *silam*. The product showed no symptoms on the 15th day of storage and was acceptable in terms of sensory quality up to 15 days under vacuum packaging. Thus, the present study shows that vacuum packaging could be useful to improve the shelf life of pork curry with *silam* without compromising the physico-chemical, microbiological and sensory properties of the product.



Keywords: Pork; *Silam*; traditional; vacuum packaging; quality


## 1. INTRODUCTION

Traditional foods are part of the folklore of a country or a region. Due to changes occurring in the lifestyle of today's population, some of the traditional products are at a risk of disappearing. Therefore, it is very important that these products are researched, documented, and saved as part of a national; state or region culture [1]. The standardization of traditional meat products has made a considerable progress in India as the demand for traditional meat products is ever growing due to rapid urbanization and industrialization [2]. Nagaland is known for its incomparable traditional and cultural heritage and for its unique cuisine. The local cuisine varies from tribe to tribe. In most of the cuisine that are prepared, both vegetables and meat are usually boiled. The meat used is often smoked, dried or fermented and various Naga tribes have their own cooking procedure especially the type of seasonings used. Some common dishes of Nagas are fermented bamboo shoot with fish and pork, *Axone* and *Anishi* with smoked pork. Naga food tends to be spicy usually with chilies, ginger and garlic. The garlic and ginger leaves are also used in cooking with meat. Amongst the tribal and urban population of Nagaland the traditional pork and pork products consumption has been in rise. One of the common ingredients I *Silam* that often added with pork to make a popular dish is readily available in the local market of Nagaland. According to Mandal et al. [3], *Perilla* oil is very similar to flax oil with respect to fatty acid composition. They reported omega-6 fatty to omega-3 fatty acid ratio of 0.33:1 and omega-3 rich PUFA composition of about 79.6%, which is similar to flax oil. Although, *Perilla* is an important food and oil seed crop of NEH region of India, however, no systematic cultivation practices being followed, as it is grown in kitchen garden and in *jhoom* (shifting) land. Thus are produced in very limited quantity for personal uses [4].

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 METHOD

### 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$^0$C) until use. The required portion of the frozen meat for the experiment was taken out and kept at refrigeration temperature (4±1$^0$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 product formulation consisted of 55% pork, non meat ingredients traditional ingredient *Silam* paste 10%, salt 1.5%, ginger 2%, green chilies 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$^0$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. QS500VMG-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 [5] methods.

The pH of the samples was determined as per the method of Pippen et al. [6] 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. [7]. The tyrosine value was determined as described by Strange et al. [8].

**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 [9].

**2.4.2.2 *Total Viable Psychrophilic Bacterial Count (Tvpbc)***

The Total viable psychrophilic bacterial counts of "pork with *Anishi" were* determined by the procedure described by the APHA [9].

***2.4.2.3 Coliform Count***

Coliform counts were enumerated by following standard techniques [10]. It was done by inoculating 1ml of the diluents in Endo agar followed by incubating at 37ºC for 24h. The average number of colonies counted was then expressed as the presence or absence of coliforms in samples.

***2.4.2.3 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 37ºC up to 72h [10].

**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 $10^5$/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. [11].

## 2.5 Statistical analysis

The results were analyzed statistically following the standard statistical method as described by Snedecor and Cochran [12] 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 days mean showed a significant ($p<0.01$) decline in pH with increasing storage period up to 15 days. Incze [13] 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 [14] 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. [15] reported first decrease and then increase in the moisture content and proposed that it might be due to break down of protein which releases water at later stage. The ether extract percent were highly significant ($p<0.01$) difference in traditional pork products under vacuum packaging at refrigeration storage.



Table 1. Changes in physicochemical characteristics of vacuum-packaged, pork curry with *Silam* during refrigeration storage ($4\pm1^{o}C$)

| Parameters | Mean±SE of different days | | | |
|---|---|---|---|---|
| | **0** | **5** | **10** | **15** |
| Moisture (%) | $^{a}68.97\pm0.86^{B}$ | $^{a}68.83\pm0.89^{A}$ | $^{a}68.45\pm0.86^{C}$ | $^{a}68.31\pm0.27^{B}$ |
| Ether extract (%) | $^{b}8.03\pm0.79^{A}$ | $^{b}8.19\pm0.38^{A}$ | $^{ab}9.43\pm0.34^{A}$ | $^{a}10.04\pm0.29^{A}$ |
| Total Ash (%) | $^{a}6.29\pm0.13^{A}$ | $^{a}6.19\pm0.34^{A}$ | $^{a}6.11\pm0.34^{A}$ | $^{a}5.55\pm0.11^{AB}$ |
| Crude Protein (%) | $^{a}16.01\pm0.16^{BC}$ | $^{b}15.02\pm0.26^{B}$ | $^{b}14.76\pm0.25^{B}$ | $^{b}14.81\pm0.33^{B}$ |
| pH | $^{a}5.89\pm0.01^{B}$ | $^{a}5.90\pm0.03^{AB}$ | $^{ab}5.62\pm0.09^{A}$ | $^{b}5.52\pm0.15^{A}$ |
| TBARS value | $^{c}0.65\pm0.03^{C}$ | $^{a}0.88\pm0.11^{A}$ | $^{b}1.21\pm0.05^{A}$ | $^{b}1.38\pm0.02^{A}$ |
| Tyrosine value | $^{a}58.00\pm0.25^{B}$ | $^{a}58.47\pm0.29^{AB}$ | $^{b}67.64\pm0.18^{C}$ | $^{c}73.39\pm0.59^{C}$ |

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

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. [16] 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 [17] who 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. But 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 vacuum-packed refrigerated storage. A positive correlation between microbial load and TBA value was reported by Sudheer et al. [18]. 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 [19]. 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 [20] who reported the increased tyrosine value in beef during storage due to the formation of free amino acids from denaturation process. Lalchamliani et al. [21] reported similar results in *Vawksa rep* samples stored under different aerobic vacuum packaging condition at $4\pm1^{o}C$. Anandh [14] also reported that tyrosine values increase on vacuum packaged, boiled restructured buffalo meat rolls during refrigerator storage ($4\pm1^{o}C$).

### 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.

Table 2. Changes in microbial profile of vacuum-packaged pork curry with *Silam* during refrigeration storage ($4\pm1^{o}C$)

| **Parameters** | **Mean±SE of different days** | | | |
|---|---|---|---|---|
| | **0** | **5** | **10** | **15** |
| TPC (cfu/g) | $^{a}1.98\pm0.05^{A}$ | $^{ab}2.27\pm0.02^{B}$ | $^{b}2.58\pm0.05^{A}$ | $^{c}3.21\pm0.24^{A}$ |
| Psychrophilic count (cfu/g) | $^{a}1.78\pm0.11^{A}$ | $^{b}2.08\pm0.03^{A}$ | $^{c}2.32\pm0.02^{A}$ | $^{d}2.56\pm0.03^{A}$ |
| Coliform count (MPN/g) | <3 | <3 | <3 | <3 |
| Yeast and mould count (cfu/g) | ND | ND | ND | ND |

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

During the storage period, microbiological counts were well below the standards for cooked products [19]. Kumar et al. [22] 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 [23]. The low microbial counts of present study were in accordance with Sinhamahapatra et al. [24] on vacuum-packed chicken meat balls and Anandh [14] 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 3. Changes in sensory characteristics of vacuum- packaged pork curry with *Silam* during refrigeration storage (4±1$^{o}$C)

| **Parameters** | **Mean±SE of different days** | | | |
|---|---|---|---|---|
| | **0** | **5** | **10** | **15** |
| Appearance | $^{a}$6.60±0.08$^{BC}$ | $^{b}$6.11±0.05$^{A}$ | $^{b}$6.17±0.06$^{C}$ | $^{b}$6.00±0.00$^{C}$ |
| Flavour | $^{a}$6.74±0.07$^{B}$ | $^{b}$6.34±0.08$^{B}$ | $^{bc}$6.23±0.07$^{B}$ | $^{c}$6.11±0.05$^{C}$ |
| Juiciness | $^{a}$6.94±0.04$^{B}$ | $^{c}$6.20±0.07 $^{C}$ | $^{c}$6.11±0.05$^{C}$ | $^{b}$6.43±0.08$^{B}$ |
| Tenderness | $^{a}$7.00±0.00$^{C}$ | $^{b}$6.29±0.08$^{B}$ | $^{bc}$6.17±0.06$^{C}$ | $^{c}$6.11±0.05$^{B}$ |
| Overall acceptability | $^{a}$7.00±0.00$^{B}$ | $^{b}$6.14±0.06$^{A}$ | $^{bc}$6.06±0.04$^{A}$ | $^{c}$6.00±0.00$^{C}$ |

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
[a]Sensory attributes were evaluated on 7-point hedonic scale (where 1= undesirable and 7 = very desirable)

Decreased in overall acceptability scores with increasing storage period might be due to decrease in appearance, flavour, juiciness and tenderness scores. The possible reason for decrease in appearance scores during refrigerated storage might be due to surface drying of lipid oxidation causing non-enzymatic browning [25]. Flavour reduction during storage might be due to microbial growth and lipid oxidation [26]. Dehydration and moisture reduction of the product with advancement of refrigerated storage could be the reason for lower juiciness scores. Similar observation of decreased in overall acceptability with increasing storage period was also reported by Devatkal and Mendiratta [26] in pork rolls.

## 4. CONCLUSION

Based on the above results, it can be 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.

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