Journal of Animal Research: v.12 n.05, p. 667-673. October 2022

DOI: 10.30954/2277-940X.05.2022.8

Physico-chemical and Sensory Attributes of Traditional Pork Products Incorporated with *Anishi* at Refrigerated Storage (4±1ºC) Under Vacuum Packaging

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Received: 15 July, 2022 **Revised:** 08 Sept., 2022 **Accepted:** 12 Sept., 2022

ABSTRACT

The present study was conducted to evaluate the physicochemical parameters, microbial quality and sensory attributes of ready-to-eat pork with *Anishi* (*Colocasia esculenta* [L] Schott), a traditional pork item of Nagalandup to 15 days of refrigerated storage at (4±1ºC) that was kept under vacuum packaging. A significant decrease in pH, moisture and crude protein was observed with an increasing storage period. However, no significant difference in overall days mean was observed from 0 to 15 days of storage. A significant ($p<0.01$) increase in TBARS value and tyrosine value was observed with an increase in the storage period. Microbiological counts increased with the advancement of the storage period. However, throughout the storage period, all microbial counts were within the acceptable limits of pork with *Anishi*. The product did not show any symptoms of spoilage such as off odour and surface slime on day 15 of storage and was acceptable for sensory quality up to 15 days of refrigerated storage under vacuum packaging. Thus, the present study indicates that vacuum packaging could be used to improve the shelf-life of traditional pork products incorporated with *Anishi*.

HIGHLIGHTS

- Vacuum packaging was found to have a definite advantage in preserving the sensory quality.
- The optimum self-life of pork products with *Anishi* at refrigerated temperature with vacuum packaging was found to be 15 days.

Keywords: Pork, *Anishi*, vacuum packaging, Physico-chemical quality

Traditional food products have a significant role in developing and preserving the cultural heritage of different regions of the world/globe for thousands of years. They include foods consumed locally and regionally for an extended period (Grujic *et al.*, 2012). Due to changing lifestyle of today's population, some of the traditional products are at risk of disappearing. Therefore, it is imperative that these products are researched, documented, and saved as part of a national, state or regional culture (Weichelbaum *et al.,* 2009). Meat and meat products are in great demand in the North Eastern Region of India, including the state of Nagaland. Among the meat consumed by Naga people, pork is the most preferred one, followed by beef and poultry. Almost cent per cent population of Nagaland consumes meat, and there is no taboo associated with the consumption of meat. Nagaland is known for its incomparable traditional and cultural heritage and unique cuisine. The local cuisine varies from tribe to tribe. In most prepared cuisine, both vegetables and meat are usually boiled. The meat used is often smoked, dried or fermented, and various Naga tribes have their cooking procedure, especially the type of seasonings used. Some typical pork dishes of Nagas are pork prepared with fermented bamboo

How to cite this article: Sangtam, H.M., Laskar, S.K., Thomas, R. and Das, A. (2022). Physico-chemical and Sensory Attributes of Traditional Pork Products Incorporated with *Anishi* at Refrigerated Storage (4±1ºC) Under Vacuum Packaging. *J. Anim. Res.,* **12**(05): 667-673.

Source of Support: None; **Conflict of Interest:** None

shoot, *Axone* and *Anishi* with smoked pork. *Anishi* cakes (Fig. 1) are prepared from the Colocasia plant (*Colocasia esculenta* [L] Schott) (Fig. 2). Naga food tends to be spicy, usually with chillies, ginger and garlic. The garlic and ginger leaves are also used in the meat cooking process. Various types of food packaging, combined with different storage techniques, can be used to extend the shelf-life of meat. The causes of product deterioration are microbial spoilage, moisture loss, colour change and oxidative rancidity (Sinhanahapatra *et al*., 2013).

Fig. 1: Colocasia Plant

Packaging meat products is vital for extending shelf-life and preserving the quality of the products. Packaging also helps in handling and marketing these products. The packaging materials act as oxygen and moisture barrier. The main objective of vacuum packaging is to prevent oxidation reactions such as lipid oxidation, loss of certain vitamins, oxidative browning, loss of pigments, etc. The vacuum also prevents deterioration by aerobic microorganisms and particularly mould. Fresh meat packaged under vacuum may have a shelf-life of a few weeks under refrigeration (Berk, 2018). Vacuum packaging has proven to be efficient in extending shelf life, preserving the sensory characteristics inherent to the product for sufficiently long for its turnover (Maria *et al*., 2011).

Due to the paucity of information on the effect of vacuum packaging on quality attributes and shelf-life of such ready-to-eat traditional pork stored under refrigeration, the present study was intended to evaluate the quality and acceptability of traditional Naga pork products, *i.e.* pork with *Anishi* in refrigerated storage (4±1ºC) under vacuum packaging condition.

Fig. 2. *Anishi* cakes

MATERIALS AND METHODS

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, frozen in small unit packs of 1 kg each, and stored in a deep freezer (-18ºC) until use. The required portion of the frozen meat for the experiment was taken out and kept at refrigeration temperature (4±1ºC) overnight for thawing and subsequently used.

After the separation of fat and skin, deboning of lean meat was done manually, maintaining hygienic conditions in the laboratory. The meat was cut into 2 cm cubes and used for further processing.

Condiment and vegetables

Following condiments and vegetables were selected, *viz.*

onion, garlic, ginger, tomato and fresh green chillies, which were procured from the local market and paste were prepared in the laboratory for further use. *Anishi* was collected from the local market of Dimapur (Nagaland).

Product formulation and product preparation

The formula for traditional pork products incorporated with *Anishi* was developed after preliminary trials. The product formulation consisted of 55% pork, non meat ingredients traditional ingredient *Anishi* 5%, salt 1.5%, ginger 2%, green chillies 4%, tomato 3%, condiments (onion and garlic 4:1) 4.5% and portable water 30%. The *Anishi* cakes were cleaned with potable water thoroughly to remove any surface dirt and oven dried at 100ºC for 15 minutes. The dried cakes were grounded in powder form. Salt, water and condiments in the required proportions were used in the product formulation. The lean meat was mixed thoroughly with *Anishi,* green chillies, 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 refrigerated (4±1ºC), maintaining their identity. The samples were assessed at 0, 5, 10 and 15 days for shelf-life stability and other quality parameters.

Packaging

Vacuum packaging was done in a 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.

Analytical procedures

Physicochemical analysis

The pH of the samples was determined as per the method of Pippen *et al*. (1965) 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*. (1970). The tyrosine value was determined as described by Strange *et al*. (1977).

Proximate composition

The proximate composition of cooked pork with *Anishi* was estimated as per the AOAC (2005). The crude protein content of the samples was determined by the Micro-Kjeldahl method by KEL PLUS KES 6L (Make: Pelican Equipment, Chennai), and fat contents were determined by Soxhlet methods (Make: Pelican Equipment, Chennai; Model: KEL PLUS CLASSIC DX). The moisture content was assessed at 105°C under normal pressure by the drying method, whereas crude ash content was determined by placing the samples in a muffle furnace and operated at 525°C for 10-12 hours until white ash was obtained.

Microbiological quality

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 (2015).

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 (2015).

Coliform Count

Coliform counts were enumerated by following standard techniques (Harrigan and McCance, 2015). 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.

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 (Harrigan and McCance 2015).

Self-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.

Sensory evaluation

The traditional meat products 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*. (2004).

STATISTICAL ANALYSIS

The results were analyzed statistically following the standard statistical method as described by Snedecor and Cochran (1995) and the calculation by using SAS version-9.2.

RESULTS AND DISCUSSION

Changes in physicochemical characteristics

The physicochemical characteristics of traditional pork incorporated with *Anishi* during refrigerated storage showed a significant (p<0.01) decline in pH with an increased storage period of up to 15 days (Table 1). Similarly, in the case of aerobically packaged chevon rolls incorporated with the optimum level of Phyto extracts, the pH values revealed a gradually decreasing trend with the advancement of the storage period till the 35th day of storage in both the control and all the treatment products This could be due to presence of some fermentable carbohydrates in the product which leads to the production of lactic acid (Rathour *et al.,* 2017). Mahajan *et al.* (2019) also reported a gradual decline in pH in vacuum packaged spent hen meat nuggets up to 14 days of storage. He opined that the gradual decline in pH could be due to lactic acid produced by growing lactic acid bacteria in samples. Breakdown of meat protein and production of amines during storage is described as the reason for the increased pH value of the stored product. Giriprasad *et al*. (2015) also recorded a decrease in pH during the storage of meat products. The resultant pH changes of the present study also seemed to be governed by the relative rates of the above reactions.

Moisture content values decreased gradually during the entire period of storage. Highly significant (p<0.01) difference was observed in the treated product under vacuum packaging. Anandh (2015) also reported a decrease in moisture content in boiled restructured buffalo meat rolls in refrigerated storage under vacuum packaging conditions during 0 to 30 days of refrigerated storage. Lin *et al.* (2004) reported that vacuum packaging treatment resulted in lower product weight loss. The vacuum

Table 1: Changes in physicochemical characteristics of vacuum-packaged, pork incorporated with *Anishi* during refrigeration storage (4±1^{o}C)

Parameters	Mean (±SE) values at different days			
	0	**5**	**10**	**15**
Moisture (%)	^{a}70.90±0.81^{AB}	^{a}70.81±0.93^A	^{a}70.80±0.62^A	^{a}70.50±0.50^A
Ether extract (%)	^{c}6.45±0.18^B	^{c}6.67±0.24^B	^{b}7.40±0.12^B	^{a}8.98±0.33^B
Total Ash (%)	^{a}6.40±0.18^A	^{a}6.37±0.27^A	^{ab}6.01±0.40^A	^{b}5.49±0.15^{AB}
Crude Protein (%)	^{a}15.56±0.43^C	^{ab}15.04±0.31^B	^{ab}14.73±0.29^B	^{b}14.43±0.35^B
pH	^{a}5.81±0.02^C	^{a}5.73±0.03^C	^{b}5.43±0.11^A	^{c}5.24±0.04^A
TBARS value (mg malonaldehyde/kg)	^{a}0.78±0.04^{AB}	^{b}1.14±0.18^A	^{b}1.20±0.05^A	^{b}1.38±0.06^A
Tyrosine value (mg/100gm)	^{a}60.07±0.24^A	^{a}60.57±0.55^A	^{b}62.57±0.09^B	^{c}78.78±0.46^B

Means with different superscript in column (capital letter) differ significantly (p<0.01); Means with different superscript in row (small letter) differ significantly (p<0.01).

packaged pork products showed a highly significant ($p<0.01$) increase inether extract per cent along with an increased storage period under refrigeration. Naveen *et al.* (2016) reported that refrigerated storage of duck meat sausages for 10 days has significantly ($p<0.01$) increased the mean per cent ether extract values.There was a highly significant ($p<0.01$) decreasing trend in the total ash content of the vacuum packaged products during increased storage days. Akhter *et al*. (2009) also observed decreasing trend in ash content during storage of dried preservation technique on the nutrient content of beef.

A decreasing trend was observed in the products during the storage period under vacuum packaging. Highly significant ($p<0.01$) decrease in the per cent of protein was observed in the pork product during the storage period. Progressively increased ether extract content with the advancement of the storage period resulted in the significant decrease in protein content of the cooked pork products in the present study. Wazir *et al.* (2019) also reported that high-fat content lowered protein in cooked beef and chicken products. Another reasonfor decreasing protein content might be the breakdown of protein during the storage of the products due to the enzymatic action of microbes. The TBARS value was observed with an increase in the storage period. However, the values remained within the threshold limit of 1-2 mg malonaldehyde/kg of the pork product during the entire storage period under vacuum packaging. Devatkal *et al*. (2014) found that TBARS value cooked goat meat nuggets stored under vacuum packaging at 4 ± 1 °C for 25 days significantly increased during the storage period. The increase in TBARS values during storage might be attributed to lipid oxidation. A positive correlation between microbial load and TBA value was reported by Sudheer *et al.* (2011). In the present study, tyrosine values were observed in the product during the storage period under vacuum packaged refrigerated storage. Lalchamliani *et al.* (2015) reported a similar increasing trend throughout the storage period intraditional pork products (*Vawksa rep*) stored under different aerobic and vacuum packaging under the refrigerated condition at 4±1ºC. Anandh (2015) also reported that tyrosine values increase on vacuum packaged, boiled, restructured buffalo meat rolls during refrigerator storage (4±1ºC).

Changes in microbial quality

The mean values for the microbial profile of pork with *Anishi* during refrigerated storage are presented in Table 2. TPCs and psychrophilic count were increased significantly ($p<0.01$) with an increasing storage period. However, the product did not show any symptoms of spoilage such as off odour and surface slime on 15 days of storage. During the storage period, microbiological counts were well below the standards for cooked products (Jay, 1996). Gamit *et al*. (2020) observed that microbial count increased significantly ($p<0.05$) with the advancement of the storage period of 9 days in chicken meat cutlets prepared with an optimized level of finger millet flour. Kumar *et al*. (2007) also reported a gradual but significant increase in total viable counts throughout the storage period in pork nuggets. The low microbial counts of the present study were in accordance with Sinhamahapatra *et al*. (2013) on vacuum-packed chicken meatballs and Anandh (2015) in boiled restructured buffalo meat rolls in refrigerated storage under vacuum packaging conditions. The coliform count was less than 3 (<3) in all the storage periods of vacuum packaging. However, yeast and mould counts were not detected during the entire storage period of vacuum packaged pork products.

Table 2: Changes in microbial profile of vacuum-packaged pork incorporated with *Anishi* during refrigeration storage (4±1ºC)

Parameters	**Mean (±SE) values at different days**			
	0	**5**	**10**	**15**
TPC (cfu/g)	^{a}1.84±0.09^{A}	^{ab}2.12±0.04^{A}	^{b}2.47±0.08^{A}	^{c}3.18±0.29^{A}
Psychrophilic count (cfu/g)	^{a}1.76 ±0.10^{A}	^{a}1.95±0.08^{A}	^{b}2.30±0.04^{A}	^{c}2.56±0.04^{A}
Coliform count (MPN/g)	<3	<3	<3	<3
Yeast and mould count (cfu/g)	ND	ND	ND	ND

Means with different superscript in column (capital letter) differ significantly ($p<0.01$); Means with different superscript in row (small letter) differ significantly ($p<0.01$).

Table 3: Changes in sensory characteristics of vacuum- packagedpork incorporated with *Anishi* during refrigeration storage (4±1ºC)
Sensory attributes

Parameters	Mean (±SE) values at different days			
	0	**5**	**10**	**15**
Appearance	$^{ab}6.34\pm0.08^{A}$	$^{b}6.20\pm0.07^{A}$	$^{a}6.51\pm0.09^{B}$	$^{c}5.31\pm0.08^{B}$
Flavour	$^{a}6.63\pm0.08^{B}$	$^{b}6.37\pm0.08^{B}$	$^{b}6.29\pm0.08^{B}$	$^{c}5.29\pm0.10^{B}$
Juiciness	$^{a}6.86\pm0.06^{B}$	$^{b}6.43\pm0.08^{B}$	$^{b}6.31\pm0.08^{B}$	$^{c}5.23\pm0.11^{A}$
Tenderness	$^{a}6.86\pm0.06^{B}$	$^{b}6.31\pm0.08^{B}$	$^{b}6.37\pm0.08^{BC}$	$^{c}5.43\pm0.09^{A}$
Overall acceptability	$^{a}7.00\pm0.00^{B}$	$^{b}6.60\pm0.08^{B}$	$^{b}6.49\pm0.09^{B}$	$^{c}5.37\pm0.08^{B}$

Means with different superscript in column (capital letter) differ significantly (p<0.01); Means with different superscript in row (small letter) differ significantly (p<0.01).

Changes in sensory attributes

The mean values for sensory attributes of pork with *Anishi* 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. A decrease in overall acceptability scores with an increased storage period might be due to a decrease in appearance, flavour, juiciness and tenderness scores. The possible reason for the decrease in appearance scores during refrigerated storage might be due to the surface drying of lipid oxidation, causing non-enzymatic browning (Chenman *et al.,* 1995). Flavour reduction during storage might be due to microbial growth and lipid oxidation (Devatkal and Mendiratta, 2001). Dehydration and moisture reduction of the product with the advancement of refrigerated storage could be the reason for lower juiciness scores. A similar observation of a decrease in overall acceptability with an increased storage period was also reported by Devatkal and Mendiratta (2001) in pork rolls.

CONCLUSION

Based on the above results, it can be concluded that vacuum packaging had a definite advantage in preserving the sensory and microbial quality of traditional pork products incorporated with *Anishi*. The pork with *Anishi* had better acceptability up to 15 days of storage at 4±1ºC in HDPE pouches under vacuum packaging.

ACKNOWLEDGMENTS

Authors are thankful to Assam Agricultural University and the All India Coordinated Research Project on Post Harvest Engineering Technology, Khanapara Center for providing financial and other sorts of help to conduct the research programme.

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