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Ethnic Pork Curry Products of Assam: Production Process, Quality and Storage Stability

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ABSTRACT

Curry products are ethnic spicy Indian food products prepared with meat, vegetables, spices, condiments etc. Different curry products prepared from pork, traditionally in Assam state of North Eastern India have been documented in this study. Formulation and procedure followed for preparation of five pork curry products viz., pork - thekera tenga curry, pork - fermented bamboo shoot curry, pork - elephant apple curry, pork - banana flower curry and pork - banana stem curry was gathered by undertaking survey and interacting with local processors of the region. These products were analyzed for standard quality parameters like physicochemical characteristics, microbiological quality and sensory acceptability. Storage stability of the products under aerobic refrigeration (4±1 ºC) was also evaluated. Products were stable up to 20 days of storage under aerobic refrigeration condition. The study revealed that ingredients used in curry preparation like thekera tenga, fermented bamboo shoot and elephant apple contribute significantly to sensory attributes and also help in enhancing storage stability of the pork curry products.

Keywords: *Pig · Pork Curry, Traditional products, North east India, Storage stability*

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INTRODUCTION

North Eastern Region (NER) of India comprises eight states namely Assam, Meghalaya, Sikkim, Nagaland, Manipur, Mizoram, Tripura and Arunachal Pradesh. NER is known for its rich cultural diversity and unique food consumption habits. Pigs are an integral part of livelihood and pork is a highly preferred meat in the region. Curry products are traditional spicy Indian food products prepared with meat, vegetables, spices, condiments etc. In NER, different pork curry products are prepared using locally available ingredients and some of the ingredients commonly used are fermented bamboo shoot (Bambusa polymorpha) (Assamese name: Bahgaj), elephant apple (Dillenia indica) (Assamese name: Outenga), banana flower (Musa balbisiana) (Assamese name: Kolphul), banana stem (Musa balbisiana) (Assamese name: Posola) and thekera (Garcinia pedunculata) (Assamese name: Thekera). Each of these ingredients contributes to unique sensory and favorable physicochemical properties to the pork curry products.

Bamboo shoots exhibit a great potential as a food resource and are gaining popularity worldwide in the utilization of its shoots as healthy and nutritious food (Pandey et al 2012, Singhal et al 2013). For centuries, young edible bamboo shoots have remained one of the highly palatable dishes in delicacies. Fermented bamboo shoot is extensively used as a taste enhancer and flavor provider in the traditional cuisines prepared in the region. Several available reports indicate that fermented bamboo shoots have benefits of providing bio-nutrients and minerals in addition to enhancement of flavor and aroma (Pandey et al 2012).

Dellenia indica (DI) occurs in the moist and evergreen forests of sub-himalayan tract, from Kumaon and Garhwal eastwards to Assam, West Bengal and Orissa. The ripe fruits are gathered while the sepals thickened, which are sour in taste and widely used in flavouring of curries and preparation of jam and jelly. The acid juice is sweetened with sugar and used as cooling drink (The Wealth of India 1952). The fruits are rich in nutrients (Gopalan et al 1971) and the fruit could be processed to commercial products such as ready-to-serve beverage and squash (Saikia and Saikia 2002).

Garcinia (family: Guttiferae) is a large genus of polygamousm trees or shrubs, distributed in the tropical Asia, Africa and Polynesia, which consists of 180 species, out of which about 30 species are indigenous to India. In Assam, the sun-dried slices of the acidic fruits of Garcinia pedunculata (GP) are used in culinary purposes. Garcinia is a rich source of secondary metabolites including xanthones, flavonoids, benzophenones, lactones and phenolic acids with wide range of biological and pharmacological activities (Bennet & Lee 1989, Minami et al 1994). Fruits of Garcinia pedunculata are rich in hydroxycitric acid (HCA). HCA is a good dietary supplement to any weight management program which is a proven natural antiobese agent (Jena et al 2002). It exhibits a wide range of biological and pharmacological activities such as antimicrobial, antioxidant, anti-tumour, hepato-protective activity etc. (Negi et al 2008, Mudoi et al 2012).

Banana is a popular fruit and vegetable but the goodness of banana pseudostem is not much known to consumers. Like banana flower, banana pseudostem is also rich in potassium. The pseudostem is believed to be a diuretic, helps detoxify the body, prevents and treats kidney stones. It also contains other minerals such as calcium, iron, magnesium and phosphorus in large quantities. Furthermore, it is an abundant source of dietary fiber (Aurore et al 2009).

An intervention of food science in optimizing the preparation methods, improving hygiene parameters, and packaging can promise a lucrative business for ethnic foods in this sector for local people and may attract consumers from other parts of the country (Kadrivel et al., 2018). Hence, the current study was undertaken to investigate quality and storage stability of pork curry products

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prepared with different natural ingredients with particular emphasis on physicochemical parameters, microbiological counts and sensory attributes.

MATERIALS AND METHODS

Source of raw materials: Different pork products prepared and studied in the present work were Pork Fermented Bamboo Shoot Curry (PFBSC), Pork Outenga Curry (POC), Pork Banana Stem Curry (PBSC), Pork Banana Flower Curry (PBFC) and Pork Thekera Curry (PTC). Pork required for preparation of the products was obtained from experimental abattoir of ICAR – National Research Centre on Pig, Guwahati, Assam. All other ingredients required for preparation of products was procured from the local market.

Ingredients used for preparation of traditional pork products: Ingredients used for preparation of traditional pork products and procedure of preparation as practiced in the region was collected by undertaking survey and interacting with different restaurants and households of North Eastern Region of India. Further, preparation of the products was standardized in the laboratory with slight modifications. Ingredients and formulations of different pork products are as mentioned below.

Pork fermented bamboo shoot curry (PFBSC): Pork (800 g), fermented bamboo shoot (484 g), onion (180 g), ginger garlic paste (80 g), green chilli paste (14 g), common salt (25 g), turmeric powder (3 g), refined oil (100 ml), coriander leaves (5 g) and water (800 ml).

Pork outenga curry (POC): Pork (800 g), outenga extract (125 ml), onion (180 g), ginger garlic paste (80 g), green chilli paste (14 g), common salt (20 g), turmeric powder (3 g), refined oil (100 ml), coriander leaves (5 g) and water (800 ml). Elephant apple (Outenga) extract was prepared by cutting about 100 g seed part, triturating it in 150 ml distilled water and boiling the resultant mixture for 10 minutes at 100° C. Extract was filtered after cooling and used for preparation of the product.

Pork banana stem curry (PBSC): Pork (800 g), onion (180 g), ginger garlic paste (80 g), banana stem (500 g), green chilli paste (14 g), common salt (25 g), turmeric powder (3 g), garam masala (5 g), refined oil (100 ml), coriander leaves (5 g) and water (400 ml).

Pork banana flower curry (PBFC): Pork (800 g), banana flower (456 g), onion (180 g), ginger garlic paste (80 g), common salt (25 g), turmeric powder (3 g), refined oil (100 ml), garam masala (5 g), coriander leaves (5 g) and water (400 ml).

Pork thekera curry (PTC): Pork (250 gm), thekera (12.5 g), onion (50 g),

ginger garlic paste (25 g), green chilli paste (5 g), jeera powder (1 g), refined oil (15 ml), common salt (8 g), coriander leaves (5 g) and water (250 ml).

Method of preparation of traditional pork products: In a frying pan add refined oil. After 2 min add onion, ginger-garlic paste, green chilli paste and garam masala/ jeera powder/ turmeric as per the formulation. After 2 min add boiled pork (precooked) and mix with the ingredients properly. After that add common salt and then add fermented bamboo shoot/ Outenga extract/ banana stem/ banana flower/ thekera and water. Cook it for 5-7 min till the desired consistency of the gravy is attained. Finally for garnishing coriander leaves was added.

Evaluation of physicochemical characteristics: The pH of the pork products was determined by the method of Keller et al (1974) using a digital meter (Make: Systronics, Model: 803). Moisture, fat, protein and ash percentage of the pork products were estimated as per AOAC (1995). Thiobarbituric acid reacting substances (TBARS) of the pork products were determined using by method of Witte et al (1970).

Microbiological evaluation: Total plate count, enterobacterial count and yeast and mould count in pork products were determined following the methods described by APHA (1984) and were expressed as log10 cfu/g.

Sensory evaluation: The sensory evaluation of the pork product was carried out for different sensory attributes viz., appearance, flavour, texture, consistency and the overall acceptability by a panel of eight trained members composed of scientists and research scholars of ICAR – National Research Centre on Pig, Guwahati by using 8 point descriptive scale wherein 8 denoted "extremely desirable" and 1 denoted "extremely undesirable" (Keeton 1983). The pork products for sensory evaluation were prepared and served warm to panelists. Water was provided for oral rinsing between the samples.

Statistical analysis: All the parameters were performed in triplicate. Data were analyzed statistically following the procedure of Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Quality of traditional pork products

Physicochemical characteristics: Physicochemical properties of pork fermented bamboo shoot curry (PFBSC), pork outenga curry (POC), pork banana stem curry (PBSC), pork banana flower curry (PBFC) and pork thekera curry (PTC) is given in table 1. Comparison of physicochemical properties of five pork products revealed that the fresh meat pH, moisture, protein, fat and ash content of pork product did not vary significantly. However, the pH of cooked meat of POC and PTC was acidic as compared to that of PBSC, PFBSC and PBFC. Addition of outenga and thekera which belong to citrus family decreased the cooked meat and curry pH. The cooking yield of pork products was in the order PBSC>PTC>PFBSC>PBFC>POC. Higher yield in case of PBSC and PTC might be due to the greater retention of moisture in the products. Cooking yield is an important data that are used by the meat industry to predict the behavior of their products during processing (Ulu, 2006).

Sensory attributes: With respect to sensory attributes, PTC, POC and PFBSC were evaluated positively by the testers, achieving score of above 7 on the hedonic scale for all attributes assessed (Table 1). In case of appearance POC, PFBSC and PTC scored significantly ($p<0.05$) higher score as compared to PBSC and PBFC. The colour attributes of cooked meat products arise mainly from the pigmentation of the meat from which they were made and the additives that were used in their formulation (Serdaroglu 2006). Flavour score were in the order PTC>POC>PFBSC>PBSC>PBFC. Results indicated that addition of Garcinia pedunculata (GP), Dillenia indica (DI) and Bambusa polymorpha (BP) had better appearance, flavour and consistency characteristics. Incorporation of GP, DI and BP improved the desirable flavor of pork products. The flavor in POC might be due to the presence of oil, colouring matter, sterols, glycosides, saponins, proteins, free amino acids, sugars, free acids and tannins in the seeds of DI (Uppalapati & Rao 1980). Significantly ($p>0.05$) better flavor score obtained for PTC could also be attributed to different secondary metabolites in GP. It has been reported that Garcinia is a rich source of secondary metabolites including xanthones, flavonoids, benzophenones, lactones and phenolic acids (Bennet & Lee 1989). Since most xanthones have phenolic functional groups on a linear tricyclic ring they often exhibit a wide range of biological and pharmacological activities (Minami et al. 1994). Texture of PBSC and PBFC was significantly ($p<0.05$) lower than those of PFBSC, POC and PTC. Consistency scores of PBSC and PBFC were significantly lower than those of PFBSC and PTC. Overall acceptability of pork products was in the order PTC>POC >PFBSC> PBSC >PBFC. In case of flavor, consistency and overall acceptability PTC scored higher scores as compared to PFBSC, POC, PBSC and PBFC. Many panelists reported that they considered PTC, POC and PFBSC to be a highly acceptable product and that they would most likely to purchase if it were commercially available. The sensory characterization of PFBSC, POC, PBSC, PBFC and PTC demonstrates the market potential of these products.

Storage stability of traditional pork products

Physicochemical changes during storage: All five traditional products were stored in aerobic refrigeration condition in low density polyethylene pouches and were analyzed for physicochemical, microbiological and sensory properties at every five days interval. A significant increase in pH level was noticed in all five pork products during storage period of 20 days. This might be due to degradation of lactic acid and liberation of protein metabolites due to bacterial activity (Rao et al 1996). This increase in product pH during storage might be due to accumulation of metabolites of bacterial action on meat and meat products and deamination of meat proteins (Bachhil 1982, Jay 1986). Similar increase in pH was also reported by Nag et al (1998) in chicken nuggets, Kumar and Sharma (2004) in chicken patties, Chidanandaiah et al (2009) in buffalo meat patties, Sureshkumar et al (2010) in buffalo meat sausages, Kumar and Tanwar (2010) in chicken nuggets and Bhat et al (2011) in chevon Harrisa. The high pH values indicate the need for refrigeration and appropriate packaging during product storage. Kim and Song (2010) reported that adding citrus powder decreases the pH of food due to the effects of organic acids such as citric acid, tartaric acid, and ascorbic acid. Generally, the pH of meat products with added dietary fiber is affected depending on the acidity and alkalinity of the natural source of dietary fiber. Yun-Sang et al (2012) reported that citrus peel fiber significantly affected the physicochemical characteristics of chicken emulsions in model systems (Yun-Sang et al 2012).

Thiobarbituric acid reacting substances (mg malonaldehyde per kg) during storage: Thiobarbituric acid reacting substances numbers (TBARS) expressed in mg malonaldehyde/ kg units, showed an increasing trend during 0, 5, 10, 15 and 20 days storage period in PFBC, POC, PBSC and PTC (Table 2). This could be attributed to the increased rate of lipid oxidation with increasing levels of microbial population. This increase in TBARS values with storage period might be due to the lipid oxidation and the production of volatile metabolites in the presence of oxygen attributed to oxygen permeability of packaging material (Brewer et al 1992). This was in agreement with the findings of Nag et al (1998), Singh and Verma (2000), Modi et al (2009) and Bhat et al (2011) who also found a similar increase in TBARS values upon storage of different meat products. Lipid peroxidation involves generation of free radicals. Hence, one approach to assessing antioxidant activity is to examine directly free radical production and its inhibition by antioxidants. At the end of 20 days of storage period the value of TBARS in POC was significantly ($p>0.05$) lesser as compared to that of PTC, PFBSC, PBSC and PBFC. Value of TBARS in PTC and PFBC was significantly ($p>0.05$) lesser as compared to that of PBSC and PBFC. It was observed that TBARS value was influenced by the addition of DI, GP and BS in pork products. The potential of outenga and thekera in inhibiting lipid peroxidation can be attributed to its phenolics and flavanoids contents. Mudoi et al (2012) showed high content of total polyphenols and flavonoid in GP. The physiological effects of flavonoids include possible antioxidant activity, therefore, suggesting their role in prevention of coronary heart diseases including atherosclerosis (Sierens 2002). Moreover Jayaprakasha et al (2006) reported that the extract obtained from the rinds of GP extracts are free radical inhibitors and act as primary antioxidants that react with free radicals. Abdille et al (2005) reported that the methanol extract of DI fruit contains substantial amount of phenolics and it is the extent of phenolics present in this extract is responsible for its marked antioxidant activity as assayed through various in vitro models.

Microbiological changes during storage: In the present study, the mean values of Total Plate Count (TPC) and Yeast and Mould Count (YMC) of five pork products increased significantly ($P<0.05$) throughout the storage period. Nag et al (1998), Reddy and Rao (2000) and Bhat et al (2012) observed a similar increase in total plate count while studying different meat products stored at refrigeration temperature. At the end of 20 days of storage period TPC of PFBSC was significantly ($P<0.05$) lesser as compared to POC, PBSC, PBFC and PTC whereas TPC of POC and PTC was lower as compared to that of PBSC and PBFC. The lower TPC of PFBC, POC and PTC might be attributed by the addition of BS, GP and DI respectively. Microbiological safety of food products is considered to be a major concern throughout the world. The

use of chemical agents revealing antimicrobial activity is taken under consideration for inhibiting microbial growth. Traditional antimicrobials such as acetic, benzoic, lactic, propionic and sorbic acids and nitrite and sulfites have been used for many years to control growth of microorganisms in foods (Sofos et al 1998). Moreover different investigations are performed depicting the antimicrobial activities of BS (Thomas et al 2016), DI (Uppalapati & Rao 1980) and GP (Negi et al 2008). In view of raising concern among consumers on utilizing synthetic compounds in food products, BS and GP hold good potential as an organic alternative for food preservation.

Sensory score during storage period: The mean sensory scores of aerobically packaged pork products during storage at 4±1°C are given in Table 3. Scores for all the sensory attributes for the products decreased during the storage period. The mean scores of all the sensory parameters of PFBSC, POC, PBSC, PBFC and PTC decreased significantly ($p<0.05$) during refrigerated storage period of 20 days. The decrease in appearance scores might be due to pigment and lipid oxidation. A decrease in appearance and colour scores of meat products with increase in storage period was also reported by Nag et al (1998) in chicken nuggets, Reddy et al (2000) in pork sausages and Bhat et al (2011) in chevon Harrisa. In the present investigation, it is found that flavor and colour of PTC, POC and PFBSC scored significantly ($p<0.05$) higher as compared to PBSC and PBFC throughout the storage period. This might be due to the potent antioxidant activity of GP, DI and BS contributing to the scavenging of free radicals produced from lipid peroxidation. Many researchers have investigated that lipid peroxides and reactive oxygen species are involved in the development of a variety of diseases including cancer and also accelerated aging. The secondary product of lipid peroxidation, especially malondialdehyde are themselves reactive (Kehrer 1993). On the other hand antioxidants are added to the food products to help guard against food deterioration by preventing or deterring free radical induced lipid peroxidation (Halliwell et al 1995, Lopez et al 2007). The texture score of PBFC and PBSC was lower than those of PTC, POC and PFBS during entire period of storage. Dehydration or loss of moisture during storage caused the pork products to retain lesser consistency and texture scores. The scores for overall acceptability also decreased significantly ($P<0.05$) during storage. This decrease in overall acceptability scores during refrigerated storage might be reflective of the decreasing trend in the rating of scores in flavour, consistency and texture attributes. Pork products prepared using GP as main ingredients showed highest acceptability during storage for a period of 20 days. GP incorporation significantly improved the sensory parameters as compared to the other pork products.

CONCLUSION

PTC, POC and PFBSC were acceptable to the panelist and had good physicochemical properties with total aerobic counts in acceptable range during 20 days of storage at refrigeration (4±10 C). The incorporation of GP, DI and BS in PTC, POC and PFBSC significantly reduced quality deterioration by reducing TBARS as compared to PBSC and PBFC. Overall acceptability were in the order PTC>POC>PFBSC>PBSC>PBFC. In case of flavor, consistency and overall acceptability PTC was significantly better which might by attributed by the addition of GP in PTC. Results indicated that addition of GP, DI and BS incorporation leads to better appearance/colour, flavour and consistency characteristics to the pork products thus improving the desirable flavor of the pork products. It can be concluded that ingredients used in preparation of traditional pork products of north eastern India possess several functional benefits in terms of enhancing the shelf life and acceptability of pork products. These benefits need to be studied further and popularized among commercial meat processors.

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ETHICS STATEMENT: Not Applicable

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