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Research article

Nutritional and phenol content of traditionally processed ethnic foods of Tripura, India

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Abstract: Traditional foods are an integral part of the daily life of the native people of Northeast India. These food items have medicinal, ritual and cultural importance with export market potential. The methods of preparation are passed on from one generation to another. Therefore, scientific documentation of these important ethnic foods is necessary to preserve traditional knowledge. In addition, the knowledge of the nutritional properties of these ethnic foods are lacking. Therefore, the present study was an endeavor to document and to study the nutritional aspects of five selected traditional ethnic foods of Tripura. The survey was conducted to know the preparation method of ethnic foods. The raw and processed five ethnic foods were procured from various markets and nutrients such as protein, carbohydrate, phenol and fat were estimated. The nutritional and phenols were compared in raw and processed foods. The survey indicated that out of five two are fermented foods and three are processed before consumption. The results of nutritional analysis obtained from this present assessment revealed that maximum carbohydrate and fat were recorded in *Bangwi* (raw and processed) whereas minimum carbohydrate and was noted in *Orai Bwlai Kwran* (raw and processed) and *Muya Kwran* (raw and processed). Maximum protein was observed in *Batema* and minimum in *Muya Kwran* in raw form while in processed food items maximum and minimum protein were recorded in *Khaklu Kwran* and *Bangwi*, respectively. In raw food, maximum phenol was observed in *Orai Bwlai Kwran* and minimum in *Bangwi* while in processed food items maximum and minimum phenol were recorded in *Muya Kwran* and *Bangwi*, respectively. The results of the nutritional properties and phenols of traditional foods obtained from the present study are discussed.
Keywords: Nutrition - Phenols - Fermented foods - Traditional knowledge.

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INTRODUCTION

Traditional foods prepared from various phytoresources play an integral role in the everyday diet of the indigenous people of Northeast India. These fermented food products also have a pivotal role in the economy generation of the indigenous people. Each of the indigenous community has their methods for the preparation of traditional food products and these knowledge they have acquired from their antecedent and will pass them to their descendants. These fermented food products also have enormous ritual, cultural and medicinal importance. The traditional knowledge used to prepare plant-based vegetable foods, beverages, boiled foods, fermented foods and nutritionally rich foods from various indigenous crop plants, forest products and meat of wild and domestic animals. The processing of these seasonal foods not only enhanced their shelf life but also enrich nutritional value and flavours (Singh *et al.* 2018).

Fermentation, the desirable biochemical alteration of principal food matrix is carried out by associated microflora and their enzyme (Kahajdova & Karovicova 2007) used to enhance the bioaccessibility, bioavailability of nutrients (Hotz & Gibson 2007) and improves organoleptic properties along with shelf life

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extension (Steinkraus 1994, Li *et al.* 2007, Chaves-Lopez *et al.* 2014). Fermented food products are enriched with proteins and vitamins (Olasupo 2006, Okechukwu *et al.* 2012). Fermentation of food grains improves the protein and starch digestibility (Ali *et al.* 2003); mineral bioavailability (Chauhan *et al.*1986) and enhancement of nutritive value (Keenan *et al.* 2005). Fermented food products have been prepared by different civilization indigenously (Joshi *et al.* 2015) for the domestic preparation and preservation of foods (Motarjemi 2002).

This present study was aimed to assess the traditional mode of household-level food preparation and to analyse nutritional properties and phenol concentrations of certain ethnic foods of Tripura, India.

MATERIALS AND METHODS

Field survey

Field surveys were conducted in four markets to collect the food items and for gathering information regarding the preparation methods using traditional skills. The information was gathered for five indigenous food items preparations from the elderly persons and women of certain ethnic communities near the market areas. The items were prepared and eaten by the Debbarma community of Tripura, Northeast India. The selected processed food items, plants and plant parts used in the food, their collection sites and respective market prices are presented in table 1.

Table 1. Plants and plant parts and their respective market values used in different food item preparation.

Food item	Plants used	Vernacular name	Family	Parts used	Place of collection	Market value (INR)
Bangwi	*Oryza sativa* L.	Mamira (D), Binnichal (B)	Poaceae	Seed	Lake Chowmani	40/kg
Batema	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Batima (D), Baghadhuma (B)	Araceae	Tuber	Kanchanmala	60/kg
Khaklu Kwran	*Benincasa hispida* (Thunb.) Cogn.	Khaklu (D), Chalkumor (B)	Cucurbitaceae	Fruit	Machmara	30/piece
Muya Kwran	*Melocanna baccifera* (Roxb.) Kurz	Muya (D), Baskorol (B)	Poaceae	Tender shoots	Lake Chowmani	60/kg
Orai Bwlaih Kwran	*Glycosmis arborea* (Roxb.) DC.	Orai (D), Ban nimbu (B)	Rutaceae	Leaves	Dainmarapara	40/kg

Note: D- Debbarma, B- Bengali.

Estimation of total carbohydrate

Carbohydrate in the ethnic foods was determined (Sadasivam & Manickam 1996). 100 mg of each of the selected food items (raw and processed) was taken into boiling tubes and hydrolyzed by keeping it in a boiling water bath for 3 hours with 5 ml of 2.5 N HCl and then allowed to cool at room temperature followed by neutralization with pellets of sodium carbonate until the effervescence ceases. After that, the volume was made up to 10 ml and centrifuge at 5000 rpm for 15 minutes. The supernatant was collected and 1 ml was taken for analysis. The volume is made up to 1 ml in all the tubes including the sample tubes by adding distilled water. Then 4 ml of 2 % anthrone reagent was added and heated for 10 minutes in a boiling water bath and then cooled at room temperature. The absorbance was taken at 630 nm using Spectrophotometer (UV-VIS Biospectrometer, Eppendorf). The standard was prepared using Glucose.

Analysis of protein

The protein of raw and processed traditional foods was determined (Sadasivam & Manickam 1996). 100 mg of the sample was ground well with a pestle and mortar in 10 ml of the potassium phosphate buffer (0.1 M, pH 7.5) and centrifuge at 5000 rpm for 15 minutes. The supernatant was used for protein estimation after discarding the pellet. From the supernatant 1 ml of sample was taken in dried test tubes and 5 ml of reagent 'C' was added. The mixing of reagent 'A' and reagent 'B' in a ratio (50:1 v/v) yield reagent 'C'. Reagent 'A' is the mixture of 2% Na_2CO_3 and 0.1 N NaOH and reagent 'B' is the mixture of 0.5% CuSO4 and 1% Na-K tartarate. The solution was shaken vigorously and allowed to stand for 20 minutes. After that 0.5 ml of Folin-Ciocalteu reagent was added and incubated at room temperature for 30 minutes. At 660 nm, absorbance was measured using a Spectrophotometer. The standard was prepared using Bovine Serum Albumin (BSA).

Determination of fat

The fat content was determined (AOAC 1960). 2 g of the samples were taken in dried test tubes and 10 ml of petroleum ether was added on each of the test tubes. The test tubes were sealed with cotton and allowed to stand

for 16 hours. After 16 hours the petroleum ether was evaporated to dryness and the weight of the test tubes before and after was determined.

Analysis of total phenol

Total phenol content was determined (Ferreira *et al*. 2007). 200 mg of food samples (raw and processed) were crushed in 1 ml of methanol makeup to 10 ml with distilled water and centrifuged for 20 minutes at about 5000 rpm. 1 ml supernatant was taken in separate test tubes and 1 ml Folin-Ciocalteu reagent was added. 1 ml of 20 % Na_2CO_3 was added. The reaction was kept in the dark for 90 mins and the absorbance was measured at 725 nm. Gallic acid was used as standard.

RESULTS

Mode of preparation of ethnic traditional foods

Batema: It is one of the important traditional food items of Tripura. This food item is prepared from the tuber of *Amorphophallus paeoniifolius* (Dennst.) Nicolson. For the preparation of *Batema* (Fig. 1), the tubers were washed thoroughly with running tap water to remove the tuber adhering soil particles and organic debris. The upper skin was peeled off and cut into small pieces (approximately 1 cm in thickness) and immersed into stainless steel utensils for boiling. After that, the pieces of *Batema* tuber were crushed with *Chakhutui Butui* (Kharpani) and large flat cakes were prepared. Kharpani water was prepared by dropping water through a bamboo strainer commonly known as *chekhok* which is having ash in it. Kharpani is used to prepare some important dishes of the ethnic people of Tripura. *Batema* has a very short shelf-life of 2–3 days and the storing duration can be enhanced by boiling the food item with Kharpani.

Figure 1. *Batema* cakes from the local markets, a traditional preparation used in ethnic food recipe of Tripura.

Bangwi: It is a widely used traditional food item used in cultural and ritual practices due to its palatability and delicacy. For the preparation of *Bangwi*, the grains of *Oryza sativa* L., Shada Birain (sticky rice) were dipped into water for overnight. On the next morning the rice was taken out and mixed with small slices of onion, garlic and salt. After that the mixture was wrapped with either large leaves of banana (*Musa* sp.) or *Bangwi pata/ Laihru Bwlaih* (*Maranta* sp.), usually banana leave use when *Laihru Bwlaih* is not available. The cone shape of rice results by using Yaruk *i.e.*, thin strips of bamboo. This preparation was allowed to boil (approximately 45 minutes) in a container with a tight lid. Nowadays ghee, cashew, nuts, raisins are also mixed with the onion, garlic and salt as supplementary material to boost the delicacy of *Bangwi* (Fig. 2).

Figure 2. A, *Bangwi* wrapped in banana leaves in container, traditional rice preparation of Debbarma people; **B**, *Bangwi* unwrapped in leaves.

Muya Kwran: Freshly collected tender shoots of *Muya* (*Melocanna baccifera* (Roxb.) Kurz) was collected from local markets and washed thoroughly to remove the adhering soil particles and other debris followed by cutting transversely at 0.5 cm in thickness. Then the slices of bamboo shoots are sundried until they dried fully. These dried samples are now ready for use can be stored for several days if the preparation is not disturbed (Fig. 3).

Figure 3. *Muya Kwran*, a sun dried traditional processed vegetable of Tripura.

Khaklu Kwran: *Khaklu* (*Benincasa hispida* (Thunb.) Cogn.) was cleaned and washed properly and followed by cutting transversely at 0.5 cm in thickness. Then the pieces of *Khaklu* were allowed to dry under strong sunlight for 3–4 days. After that samples were ready for consumption. The samples can be stored for a longer period if it is placed in a tight lid container (Fig. 4).

Figure 4. *Khaklu Kwran*, a sun dried traditional processed vegetable of Tripura

Orai Bwlaih Kwran: Healthy and fresh leaves of *Orai* (*Glycosmis arborea* (Roxb.) DC.) were plucked and washed with tap water to remove the adhering soil particles. The fresh leaves of *Orai* were allowed to dry under bright sunlight for at least 3–4 days. The completely dried leaves were ready for use. The dried leaves can be stored for further uses (Fig. 5).

Figure 5. *Orai Bwlaih Kwran*, a sun dried traditional processed leaves used in recipe by ethnic people of Tripura

Nutritional content of traditional foods

The biochemicals of traditional processed foods are presented in table 2. Maximum carbohydrate content was noted in *Bangwi* (raw and processed) whereas minimum was noted from *Orai Bwlaih Kwran* (raw and processed). In raw food maximum protein was observed in *Batema* and lowest in *Muya Kwran* while in processed food items maximum and minimum protein were recorded in *Khaklu Kwran* and *Bangwi*, respectively. Maximum fat was noted in *Batema* (raw and processed) whereas minimum was noted in *Muya Kwran* (raw and processed).

There was higher carbohydrate concentration in *Bangwi*, *Khaklu Kwran*, *Muya Kwran* and *Orai Bwlaih Kwran* by 10.59, 23.46, 34.78 and 73.15 %, respectively in case of processed food items. However, carbohydrate decreased in *Batema* by 27.03%. An increased amount of protein was observed in *Bangwi*, *Batema*, *Khaklu Kwran*, *Muya Kwran* and *Orai Bwlaih Kwran* by 6.70, 9.64, 58.07, 128.74 and 45.49 %, respectively after processing the foods. There was an increase of fat concentration in *Bangwi*, *Batema* and *Orai Bwlaih Kwran* by 31.25, 44.26 and 64.15 %, respectively with the traditionally processing of ethnic foods. However, fat decreased in *Khaklu Kwran*, *Muya Kwran* by 14.77 and 39.02 %, respectively.

Table 2. Nutrition and phenol concentration in traditionally processed ethnic food items of Tripura

Food item	Carbohydrate (mg g^{-1})		Protein (mg g^{-1})		Fat (mg g^{-1})		Phenol (mg g^{-1})	
	Raw	Processed	Raw	Processed	Raw	Processed	Raw	Processed
Bangwi	48.43±1.08	53.56±9.66	10.58±1.27	11.29±0.70	0.96±0.13	1.26±2.18	14.85±2.26	19.64±2.14
Batema	46.57±1.37	33.98±2.04	17.63±0.73	19.33±1.36	1.22±0.43	1.76±0.21	22.00±1.81	24.79±1.98
Khaklu Kwran	30.64±1.29	37.83±3.46	15.41±2.35	24.36±3.34	0.88±0.41	0.75±0.22	20.80±1.29	27.34±1.10
Muya Kwran	35.04±2.15	47.23±2.84	10.02±1.00	22.92±3.58	0.41±0.23	0.25±0.26	21.02±0.94	29.18±1.32
Orai Bwlaih Kwran	16.24±7.35	28.12±3.78	12.77±1.82	18.58±3.46	0.53±0.79	0.87±0.31	25.77±1.09	25.98±0.34

Phenol content of ethnic foods

In raw food maximum phenol was observed in *Orai Bwlaih Kwran* and minimum in *Bangwi* whilst in processed food items maximum and minimum phenol were recorded in *Muya Kwran* and *Bangwi*, respectively. Increased amount of phenol was observed in *Bangwi*, *Batema*, *Khaklu Kwran*, *Muya Kwran* and *Orai Bwlaih Kwran* by 42.76, 10.41, 31.44, 38.82 and 0.81 %, respectively after traditional processing.

DISCUSSION

From the results obtained from this present study, it is evident that the biochemical concentrations were increased in most of the selected traditional processed food items although in *Batema* carbohydrate was decreased. The possible reason for the increase in the carbohydrate may be due to the involvement of α-amylase and maltase enzymes which degrade starch into maltodextrins and simple sugars (Osman 2011). Reduction in the carbohydrate of *Batema* after processing is in agreement with the earlier findings in other food items (Omafuvbe *et al.* 2004, Osman 2007). The decrease in the carbohydrate content in *Batema* may be due to the leaching of soluble sugar during processing or the utilization of simple sugars by the associated microflora. The fat of *Khaklu Kwran* and *Muya Kwran* also decreased after processing which is in agreement with established findings (Khetarpaul & Chauhan 1990, Zhang *et al.* 2015). On the contrary, reports are available on the enhancement of fat contents (Osman 2007, Rumiyati 2012) which was reaffirmed in this present study. The protein content of all the selected food items was increased after traditional processing which was in accord with the earlier findings (El-Hag *et al.* 2002, Doudu *et al.* 2003, Pranoto *et al.* 2013) while others observed a decrease in protein content (Osman 2011, Pranoto *et al.* 2013). The increase in the protein content may be due to the microbial degradation of complex protein resulting in the release of peptides and amino acids (Pranoto *et al.* 2013) or due to the action of extracellular enzymes produced microorganisms (Tope, 2013). The inconsistent results concerning protein content are likely due to the duration of processing and variation in the initial protein or amino acid profile of foods (Nkhata *et al.* 2018). The increased phenolic content of processed food items were recorded which corroborates earlier findings (Wang *et al.* 2014, Gan *et al.* 2016, Rocchetti *et al.* 2019). The increase in the phenolic contents is may be due to the activity of the enzymes produced by microorganisms resulting in a greater accessibility of bound and conjugated phenolic compounds through the breakdown of the cell wall matrix (Hole *et al.* 2012).

CONCLUSION

The results obtained from this study revealed that the traditional methods employed for the preparation of ethnic food products enhance the nutritional contents of most of the food items as well as there was increase in phenols. The enhancement of nutritional contents may be due to the active contributions of the associated microorganisms with these food items. However, microbes may play an essential role in ameliorating the content. Therefore, the isolation, identification and screening from the processed foods and subsequently processing the foods using these microbes may enhance quality and palatability. Thus these plant based items may serves as functional foods due to their nutrient and phenol content.

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