Research Article

Consumer Acceptance of Lactic Acid Fermented Elephant Foot Yam Pickle

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Abstract

The success of any novel food product is largely determined by the consumer acceptance of its sensory quality. Two cultivars (BCA-1 and IGMA-1) have been selected for pickle preparation due to rich in nutritional value at maturity stage and these high starch rich cultivar cubes were blanched (20 minutes at 8 kg/cm^2) and pickled by lactic fermentation through brining in common salt (NaCl 10-25%) solution, and finally 20% brine solution was found to be organoleptically most acceptable. The final product with standardized 20% brine solutions had a total soluble solids (20.71-33.25^O Brix), total sugar (1.22-1.88 %), starch (8.44-20.48 %), carbohydrate (63.67-78.00 mg/100g) and protein (3.91-5.38 %). Sensory evaluation rated the starch rich elephant foot yam lacto-pickle cubes acceptable based on texture, taste, aroma, flavor and aftertaste. From the experiment and consumers acceptance *cv.*, BCA-1 pickle was found best through out the storage period on nutritional point of view at 5% level of significance.

Keywords: *Amorphophallus paeoniifolius*, Cultivar; Organoleptic Value, Pickle, Nutrition

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Introduction

Rural people living in the geographically and socially isolated places of developing countries are often plagued by acute malnutrition. Fortifying the staple food with essential nutrients is an effective strategy to eradicate malnutrition through natural means. Elephant foot yam (*Amorphophallus paeoniifolius* Dennst-Nicolson) is cultivated extensively in rainfed and hilly tribal regions of India [1], where it's freely available. In rural areas it's used as primary major food for tribes during off-season [2]. Oxalates in tubers may either be a cause or a contributor as to the acridity, which causes irritation, and swelling of mouth and throat and their presence results it's in bitterness and astringent taste, but these cultivars content low oxalate, which are under permissible level [3].

Vegetable pickles are popular adjuncts in India, which are consumed regularly along with staple foods. Thus the pickles prepared with antioxidant rich elephant foot yam can provide essential nutrients like starch, carbohydrate, protein, total sugar, total soluble solids etc., which can help the rural people to eradicate malnutrition at cheaper cost. Among the tropical vegetable roots, elephant foot yam recently gains its importance in food and beverage industries worldwide [4]. It is perennial, herbaceous, C3 crops, classified under family Araceae and considered as staple/subsidiary food for about 500 million of global population, including tropical Asia of South-East Asian origin, and grows in wild form in the Philippines, Malaysia, Indonesia and African countries [5, 6]. Besides being used as a vegetable, the tubers can also be used for making pickles, dry and fry cubes, chips, flour, thickening agents etc. are gaining popularity. Elephant foot yam pickle prepared from starch rich corm by lactic fermentation would be a good prospect for commercialization in small-scale industries. Starch and carbohydrate rich elephant foot yam lacto pickle would be a novel product similar to lactic-fermented cucumber, garlic and cabbage, and its regular consumption would be helpful in combating night blindness, lever injury, aging and related ailments because of anti-oxidant principle. Lacto-pickle has a long history of uses in lactic acid (LA) fermentation [7] and is simple and useful to keep and/or enhance the safety, nutritional, sensory and shelf-life properties of vegetables [4]. The fermentation of vegetables into Lacto-pickles plays a crucial role in the food and provides nutritional security of the people of Asia [8]. Being rich in starch, carbohydrate, sugar, protein and organoleptic value, it offers a highly potential vegetable for lactic acid fermentation [9, 10]. In recent year, "Lacto-pickling" of elephant foot yam is one of the most important value-added practices through increasing the shelf stability of products, without causing too much increase in processed costs [11]. Elephant foot yam corms are consumed by many people as a food and widely used in many ayurvedic preparations [12] because it contains different bioactive components like alkaloids, flavonoids, phenols,

vitamins, minerals etc. [1]. It is eaten in varied manners- boiled like potatoes and eaten with mustard, as curry, as pickle after boiling with tamarind leaves, as preserve after cooking in syrup. It can also be cooked with salt, chilly, tamarind and turmeric powder and is used as curry [13]. In Assam (India), farmers consume a special dish made of elephant foot yam in the month of Bhadoh, which they perceive to be strength giving [14]. This study is aimed to evaluate the quality of elephant foot yam product *viz.* pickle, which may be important to increase the levels of nutrients as elephant foot yam corm in our daily diet.

Materials and Methods

The experiments were carried out in the laboratory of All India Coordinated Research Project on Tuber Crops, Research Complex, Kalyani (Bidhan Chandra Krishi Viswavidyalaya) West Bengal with view to analyze the physicochemical in pickles during storage. Two cultivars (BCA-1 and IGAM-1) were selected on nutritional point of view at maturity stage, and after peeling it has been sliced into suitable size of pieces (2.5X2.5X2.5 cm) for preparing cubes with the help of knife. The pieces were blanched (20 minutes at 8 kg/cm^2), and then by adding 50% of total salt and turmeric allow storing for 6 days. Remaining salt and all roasted spices with oil mixed in cubes, and then filling in glass jars, and finally stored at room temperature for their monthly nutritional evaluation.

2.1 Physico-chemical analysis

The changes in nutritional value were determined by mentioned methods *viz.*, total soluble solids in ^{O}Brix were determined by taking a direct reading of a drop of the homogenized sample in a digital Refractometer (ATAGO PR-1, Japan) with a range of 0 to 32 ^{O}Brix and resolutions of 0.2 ^{O}Brix, starch and sugar by titration method [15], carbohydrate at 630 nm [16] and protein was estimated by Lowry's method [17].

2.2 Statistical procedure

All the lab data were used to Complete Randomized Design (CRD) as suggested by Raghuramula [18]. The critical difference (CD) value at 5% level of probability was used for comparing the treatments and to find out the significant difference in between them. Each treatment was replicated for three times.

Table 1 Changes in Total Soluble Solids (°Brix) and Total Sugar (%) in elephant foot yam corms pickle during storage

MAS/ cv.	Total Soluble Solids (°Brix)						Total Sugar (%)					
	BCA-1			IGAM-1			BCA-1			IGAM-1		
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
0	33.84	32.65	33.25	35.00	30.30	32.65	1.73	1.77	1.75	1.88	1.87	1.88
1	30.90	30.95	30.93	33.30	29.80	31.55	1.69	1.51	1.60	1.80	1.82	1.81
2	30.80	30.90	30.85	31.30	27.10	29.20	1.62	1.42	1.52	1.75	1.77	1.76
3	28.54	29.93	29.24	29.70	25.80	27.75	1.48	1.27	1.38	1.70	1.74	1.72
4	26.40	27.32	26.86	27.90	24.15	26.03	1.35	1.21	1.28	1.66	1.71	1.69
5	25.80	25.10	25.45	26.20	23.97	25.09	1.35	1.21	1.28	1.63	1.68	1.66
6	25.20	24.70	24.95	24.70	23.65	24.18	1.34	1.20	1.27	1.59	1.64	1.62
7	24.90	24.30	24.60	23.80	23.22	23.51	1.34	1.20	1.27	1.55	1.60	1.58
8	24.60	23.90	24.25	22.30	22.90	22.60	1.33	1.19	1.26	1.53	1.57	1.55
9	24.20	23.70	23.95	21.80	22.60	22.20	1.32	1.18	1.25	1.50	1.54	1.52
10	23.90	23.50	23.70	21.20	22.40	21.80	1.32	1.18	1.25	1.48	1.52	1.50
11	23.65	23.20	23.43	21.50	22.25	21.88	1.31	1.17	1.24	1.44	1.49	1.47
12	23.30	22.80	23.05	21.10	21.95	21.53	1.31	1.17	1.24	1.42	1.47	1.44
13	22.90	22.20	22.55	20.80	21.70	21.25	1.29	1.17	1.23	1.39	1.44	1.41
14	22.10	21.80	21.95	20.50	21.45	20.98	1.28	1.16	1.22	1.37	1.41	1.39
15	21.80	21.10	21.45	20.20	21.22	20.71	1.28	1.16	1.22	1.35	1.39	1.37
Mean	25.80	25.50	25.65	25.08	24.03	24.56	1.40	1.26	1.33	1.57	1.60	1.58
	CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed	
M	1.221	0.611	**	1.232	0.616	**	0.429	0.215	NS	0.383	0.192	NS
Y	0.432	0.216	NS	0.435	0.217	**	0.152	0.076	NS	0.135	0.068	NS
MY	1.726	0.864	NS	1.742	0.872	**	0.607	0.304	NS	0.542	0.271	NS

Cv.- Cultivar; MAS- Months After Storage; Y- Year; M-Month; CD- Critical Difference at 5 %; S Ed- Standard Error of Deviation; R- Replication (3); NS- Non Significant; **- Highly Significant; *- Significant

Results and discussion

There were variations in TSS, total sugar, starch, carbohydrate, and protein content in pickles within the year of two selected cultivars that could be clinically important.

Total soluble solids

The results presented in **Table 1** showed that total soluble solids (TSS ^{O}Brix) content of elephant foot yam corm pickle decreased during storage in both years in both cultivars (BCA-1 and IGAM-1). The decrease in TSS ranged from 33.25 to 20.71 ^{O}Brix, while pickle prepared from cultivar IGAM-1 showed lowest TSS as compare to BCA-1 at both stages at 0 to 15 months of storage. The decrease in TSS might be due to break down of sugar in the form of water from pickles during storage.

Total sugar

The total sugar contents of elephant foot yam pickle ranged from 1.22-1.88% during different storage stages. The lowest total sugar content was found in *cv.*, BCA-1 pickle at both stages at 0 and 15 months after storage. While, the *cv.*, IGAM-1 pickle content highest total sugar content at both stages at 0 and 15 months after storage (Table 1). The decrease in sugar concentration was understandable due to the amylolytic activity of the microorganism. During organic metabolism, a part of the starch in elephant foot yam corm was converted to sugar and consequently to lactic acid. Nevertheless, all fermentable sugars generated did not convert to lactic acid; a substantial part had been probably utilized [19].

Table 2 Changes in Starch (%) and Protein (%) content in elephant foot yam corms pickle during storage

MAS/cv.	Starch (%)						Protein (%)					
	BCA-1			IGAM-1			BCA-1			IGAM-1		
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
0	18.62	17.65	18.13	21.09	19.88	20.48	5.55	5.22	5.38	5.62	4.23	4.92
1	17.31	15.39	16.35	19.23	17.31	18.27	5.41	4.98	5.19	5.26	4.08	4.67
2	16.36	14.13	15.25	17.49	15.74	16.61	5.30	4.86	5.08	4.99	3.91	4.45
3	12.86	13.39	13.13	15.89	14.98	15.44	5.20	4.74	4.97	4.89	3.87	4.38
4	11.30	10.98	11.14	14.24	13.24	13.74	5.08	4.61	4.85	4.79	3.80	4.30
5	10.98	10.12	10.55	13.15	12.48	12.81	4.97	4.50	4.74	4.65	3.65	4.15
6	9.74	9.67	9.71	12.66	11.87	12.27	4.85	4.42	4.64	4.58	3.58	4.08
7	9.43	9.29	9.36	11.79	10.24	11.01	4.72	4.20	4.46	4.42	3.49	3.95
8	9.31	9.11	9.21	10.82	9.45	10.14	4.59	4.09	4.34	4.30	3.35	3.83
9	9.24	9.08	9.16	9.35	8.89	9.12	4.47	3.91	4.19	4.21	3.20	3.70
10	9.12	8.93	9.03	9.21	8.74	8.97	4.39	3.80	4.09	4.11	3.08	3.59
11	9.09	8.95	9.02	9.12	8.61	8.87	4.21	3.69	3.95	4.01	2.97	3.49
12	8.91	8.82	8.87	8.99	8.50	8.75	4.18	3.55	3.86	3.89	2.89	3.39
13	8.83	8.75	8.79	8.88	8.38	8.63	4.09	3.48	3.79	3.81	2.80	3.31
14	8.75	8.63	8.69	8.77	8.27	8.52	4.00	3.39	3.70	3.71	2.72	3.22
15	8.68	8.59	8.63	8.69	8.19	8.44	3.91	3.31	3.61	3.65	2.64	3.14
Mean	11.16	10.72	10.94	12.46	11.55	12.00	4.68	4.17	4.43	4.43	3.39	3.91
	CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed	
M	2.152	1.077	**	2.130	1.066	**	1.913	0.957	NS	2.267	1.134	NS
Y	0.761	0.381	NS	0.753	0.377	*	0.676	0.338	NS	0.801	0.401	*
MY	3.044	1.524	NS	3.013	1.508	NS	2.706	1.354	NS	3.206	1.605	NS

Cv.- Cultivar; MAS- Months After Storage; Y- Year; M-Month; CD- Critical Difference at 5 %; S Ed- Standard Error of Deviation; R- Replication (3); NS- Non Significant; **- Highly Significant; *- Significant

Starch

Physico-chemical composition of pickle varied with cultivars and year and it was noticed that the starch content was found an in decreasing trend during the storage stages. The lowest values of starch were found in *cv.*, BCA-1 and

IGAM-1 pickle at 0 and 15 months after storage, respectively. While, the highest starch value were observed *cv.*, IGAM-1 pickle and *cv.*, BCA-1 pickle at 0 and 15 months after storage, respectively (**Table 2**). Starch content also varied from 8.44 to 20.48%. The decrease in starch content was probably due to the amylolytic activity of *Lactobacillus plantarum*, which holds conversion of starch to sugar [20-22].

Protein

The protein content was lowest in *cv.*, IGAM-1 pickle at both stages at 0 and 15 months after storage. While, the *cv.*, BCA-1 pickle content highest protein content at both stages 0 and 15 months after storage (Table 2). Decrease in protein content of corm pickle with the advancement of storage might be due to reaction of protein with salt and spices, which lead to denaturation. The range of protein content found in this experiments (3.91-5.38%) was in line with results observed by Yadav and Singh [23]. A similar finding was observed in watermelon rind pickle [24].

Carbohydrate

Carbohydrate content of elephant foot yam corm pickle also varied significantly between both cultivars (**Table 3**). At the early stage of storage *i.e.*, at 0 month of storage, the *cv.*, BCA-1 recorded the highest carbohydrate content at 0 and 15 months of storage, while *cv.*, IGAM-1 contained the lowest content of carbohydrate at 0 and 15 months of storage. Taking all the storage stages into consideration, it was observed that there was significant variation in mean carbohydrate content with the value ranging from 60.95 to 78.00 mg/100g. The reduction in carbohydrate contents is an advantage and medically recommended for diabetic patients, which is now a major health problem in Asia and Africa [25, 26].

Table 3 Changes in Carbohydrate (mg/100g) and Organoleptic Score (9-point hedonic scale) in elephant foot yam corms pickle during storage

MAS/cv.	Carbohydrate (mg/100g)						Organoleptic Score					
	BCA-1			IGAM-1			BCA-1			IGAM-1		
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
0	77.87	78.12	78.00	69.39	72.12	70.76	5.53	6.03	5.78	4.89	5.33	5.11
1	77.00	77.67	77.34	68.10	70.67	69.39	5.87	6.45	6.16	5.86	5.76	5.81
2	76.12	76.23	76.18	66.98	69.12	68.05	7.86	7.98	7.92	7.34	6.89	7.12
3	75.37	75.00	75.19	66.01	68.34	67.18	8.47	8.78	8.63	7.88	7.73	7.81
4	74.18	73.98	74.08	65.11	67.35	66.23	8.23	8.89	8.56	8.45	8.33	8.39
5	73.09	72.46	72.78	64.22	66.22	65.22	8.12	8.66	8.39	8.78	8.87	8.83
6	72.01	71.75	71.88	63.58	65.39	64.48	7.98	8.06	8.02	8.98	8.68	8.83
7	70.67	69.99	70.33	62.78	64.45	63.61	7.35	7.79	7.57	8.33	8.45	8.39
8	69.35	68.77	69.06	61.99	63.67	62.83	7.33	7.56	7.45	7.67	8.33	8.00
9	68.00	67.52	67.76	61.23	62.98	62.10	6.69	7.33	7.01	7.46	7.73	7.60
10	66.99	66.79	66.89	60.52	62.12	61.32	6.54	7.12	6.83	7.03	7.33	7.18
11	65.23	65.12	65.18	59.78	61.56	60.67	5.33	6.86	6.10	6.54	7.22	6.88
12	63.52	63.68	63.60	59.22	61.01	60.12	5.12	6.33	5.73	6.02	6.89	6.46
13	62.32	62.55	62.44	58.70	60.44	59.57	4.67	5.58	5.13	5.33	6.66	6.00
14	61.44	61.66	61.55	58.01	59.75	58.88	4.34	5.33	4.84	5.01	6.17	5.59
15	60.89	61.01	60.95	57.56	59.23	58.40	4.02	5.22	4.62	4.76	5.73	5.25
Mean	69.63	69.52	69.57	62.70	64.65	63.68	6.47	7.12	6.79	6.90	7.26	7.08
	CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed	
M	16.772	8.395	NS	14.526	7.271	NS	0.435	0.217	**	0.501	0.251	**
Y	5.930	2.968	NS	5.135	2.570	NS	0.159	0.079	**	0.183	0.091	**
MY	23.720	11.874	NS	20.542	10.283	NS	0.615	0.307	NS	0.709	0.354	NS

Cv.- Cultivar; MAS- Months After Storage; Y- Year; M-Month; CD- Critical Difference at 5 %; S Ed- Standard Error of Deviation; R- Replication (3); NS- Non Significant; **- Highly Significant; *- Significant

Organoleptic quality

The organoleptic quality of *cv.*, BCA-1 and IGAM-1 pickles were evaluated at room temperature up to 15 months of storage. It was found that the product remain acceptable at room temperature in both cultivar upto 15 month of storage and organoleptic value were found increase upto 3 month of storage in *cv.*, BCA-1 and 6 month in *cv.*, IGAM-1 fallowed by a slight decrease were observed. Organoleptic scores were judged on the basis of 9 point Hedonic Scale in which up to '4.5' rank (like slightly) of the products were considered somewhat acceptable by the panel of judges. In this study the highest organoleptic value observed in *cv.*, BCA-1 and IGAM-1 at 0 and 15 months after storage, respectively. While, the lowest organoleptic value was observed in *cv.*, IGAM-1 and BCA-1 at 0 and 15 months after storage, respectively (Table 3). Overall acceptability was found by adding scores for individual member. Significance of difference between samples was determined by analysis of variance of organoleptic data and product [18].

Conclusion

The analyzed elephant foot yam cultivar pickles contained more starch, carbohydrate and protein with this nutritious elephant foot yam pickles would lead to the availability of healthful foods to consumers at reasonable prices. These results suggest that this less familiar vegetable should not be ignored. Rather they can be used as a good alternative source of food like pickle to alleviate hunger and malnutrition, which are currently big problems in developing countries. We hope that this study will help propagate knowledge on the compositional varietal variation in elephant foot yam corms pickles, their suitability and their selection for further improvement. Furthermore, we hope this study will stimulate activity to promote the production and utilization of elephant foot yam as valuable components of a well balanced diet.

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