Study of Antioxidant Potential of Two Edible Aroids viz., Ghandiyali (*Alocasia spp.*) and Zimikand (*Amorphophallus campanulatus*) and Preparation of their Pickles

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Abstract: **Edible aroids were considered among the world's most ancient food crops that are also known for their medicinal properties. The edible aroids are known to possess a number of nutraceutical properties, however due to the presence of acridity there use in the preparation of value added products are quite limited. In the present investigation, the physico-chemical parameters of the fresh corms were recorded in two edible aroids viz., Ghandiyali and Zimikand. Further, a comparison of their antioxidant potentials was also made. Moreover, different recipes (dry and oil based) were tried for the preparation of their pickles. The pickles were subjected to the organoleptic evaluation at 30 days interval during the 90 days of storage period. The giant taro was found to be significantly rich in antioxidants with higher DPPH radical scavenging activity, total phenolic content, total flavonoid content and ascorbic acid content than the elephant foot yam. Among the treatments (giant taro oil pickle, elephant foot yam oil pickle, giant taro dry pickle and elephant foot yam dry pickle) the giant taro oil pickle was found best in organoleptic evaluation in terms of taste, appearance, aroma and flavour and overall acceptability after the storage period. Whereas, the least acridity score was recorded in giant taro oil pickle at 0 days, which remained least even after the 90 days storage.**

***Keywords*— Alocasia, Amorphophallus, Antioxidants, Pickles**

I. INTRODUCTION

Aroids (members of the family Araceae) are one of the world's most ancient food crops. They are known for their ornamental and nutraceutical properties [1, 2]. They are recognized to be the 6th most important root and tuber crops and rank 14th among the vegetables [3]. Tropical regions of Asia and America are considered as major centers of origin and diversity of the aroids [4]. The family Araceae is divided into nine sub-families consisting of about 106 genera and around 3200 species, which are distributed in almost every part of the world [5]. Among aroids *Alocasia, Amorphophallus* and *Colocasia* spp. were widely cultivated in India [6], mainly for food.

Ghandiyali (*Alocasia* spp.) is a common aroid grown in North India (mainly Himachal Pradesh) which is variously known as Lamba kachalu, Giant taro, Elephant's ear taro, False taro or Metallic taro in other parts of world [2, 7, 8] and is closely related to taro (*Colocasia* spp.) [9, 10]. Zimmikand (*Amorphophallus* spp.) is another common edible aroid grown in North India and known by various names like Elephant foot yam, Sweet yam, Whitespot giant arum, Telinga potato, Suranakand, Ole, Balukand, Suran and Zamikand [11 -14]. Plants of both *Alocasia* and *Amorphophallus* spp. are herbaceous in nature and are mostly grown in tropical to subtropical regions of South America and Asia [10, 14, 15].

Plants of both *Alocasia* and *Amorphophallus* spp. are herbaceous in nature and are mostly grown in tropical to subtropical regions of South America and Asia [10, 14, 15]. The plants of *Alocasia* spp. are thick, erect and can grow upto 4.5 m in height. The corms are elongated, cylindrical in shape (thick from center and tapering towards the ends) and are covered with the scale leaves and have white flesh. The corms of some of varieties can grow up to about 1 m (length) and up to about 20 cm thick (diameter). Whereas, the elephant foot yam plants can grow up to a height of about 1-2.5 m, and their corms (depressed globose in shape) are about 30 cm in diameter and 20 cm thick, with dirty whitish-pink flesh colour [16, 17].

Alocasia spp. is a very good source of ascorbic acid vitamin (Vit.) C, Vit. B_6, niacin (Vit. B_3), potassium, copper, manganese, dietary proteins, iron, phosphorous, zinc, thiamin (Vit. B_1), riboflavin (Vit. B_2) [18]. The of *Alocasia* spp. is reported to have the nutrient composition as protein 2.15%, starch 21.5%, sugar 0.96%, dietary fibres 1.85%, ash 0.92%, fat 0.10%, magnesium 52mg, Calcium 38mg, magnesium 52mg, potassium 267mg, sodium 30mg, iron 0.83mg, sulphur 12mg, zinc 1.57mg, copper 0.07mg, aluminium 0.36mg, manganese 0.62mg, phosphorous 58.5mg, vitamin C 15mg, Vit. B_1 0.18mg, Vit. A 0.1mg, Vit. B_3 0.9mg and Vit. B_2 0.04mg per 100g each [18, 19]. On the other hand, *Amorphophallus* spp. is good source of energy, protein, starch, minerals and sugar, the tubers show blood purifier properties and used traditionally to treat piles, asthma, tumors, abdominal disorders, constipation, seminal weakness, anemia, fatigue *etc*. [13]. It is also rich in vitamins (*viz*. Vit. A, Vit.B_2, Vit. B_1, Vit. B_3) and minerals [20]. The proximate composition of *Amorphophallus* spp., reported by Singh and Wadhwa [13] as (0.7-1.7%) sugars, (0.8-2.60%) protein, (0.07-0.40%) fat, (11-28%) starch, 327.83mg potassium, 161.08mg calcium, 166.91mg phosphorous, 3.43mg iron per 100g each. It also contains 33mg magnesium, 0.1mg copper, 0.9mg zinc, 4.2g total dietary fibres, 3mg sodium, 0.3mg Vit. B_3 and 6 mg Vit. C per100g each [21].

An anti-nutritional factor is also found in many aroid species called raphid (needle-like crystals) owing to the presence of acridity, which causes the swelling of lips, mouth, throat when eaten raw, due to presence of calcium oxalate crystals, which can easily penetrate into the skin [18, 22]. However, this calcium oxalate content in ghandiyali can be reduced through various processing treatments like washing, peeling, dicing, soaking overnight, milling and drying [23] before consumption. Like the corms of *Alocasia* spp., the tubers of *Amorphophallus* spp. (wild as well as cultivated) also possess high amount of acridity (calcium oxalates), which are variously used as a vegetable, for pickle making and also for as herbal medicine (in Ayurveda) by the people of northern and eastern states of India [12].

Alocasia spp. and *Amorphophallus* spp. were reported to possess many nutraceutical properties like antioxidant activity [24-29], anti-tumor activity [25], hepatoprotective activity [29, 30], anti-inflammatory activity [32, 33], anti-diarrheal activity [25, 31], antibacterial activity [34, 35], anthelminthic activity [24, 36], analgesic activity [25, 32, 37, 38], anti-microbial activity [24, 35], anti-diabetic activity [39, 40, 41], anti-fungal [42, 43], anti-cancer activity [13, 44]. Besides this *Alocasia* spp. also possess thrombolytic activity [24], cytotoxic [24], antihyperlipidemic activity [40], and *Amorphophallus* spp. possess gastro-protective [45], anti-convulsant [46], CNS-depressant [25], immunomodulatory [47], cytotoxic [25], anti-hyperglycemic [33], antinociceptive [33], and gastro-kinetic activities [48].

Value addition in horticultural produce (fruits and vegetables) to preserve them in the form of pickles, jams, sauces and chutneys is an age-old Indian tradition [49], helping the people to enjoy and relish their delicacies even in the off season, by Increasing their shelf life. The individual antioxidant activities of some aroids have been studied [50], but not much work on the comparison of dietary antioxidants is available among the aroids. In this regard only a few studies are available [51], and that too not among the two aroids used in the present study. Thus, the present study was carried out to compare their antioxidant potential and to evaluate the storage stability of their pickles over a period of 90 days. There are only a few reports on the sensory parameters of aroid pickles, which generally have acridity issues related with their consumption. Therefore, the present study reports the changes in their sensory parameters during storage. To best of our knowledge, this is the first study of this kind, comparing the antioxidant properties of two important edible aroids, commonly consumed in India. The study may be helpful in value addition in these aroids and in scaling up of their pickle production at industrial level. The present study also optimized the pickle preparation to reduce the acridity.

I. MATERIALS AND METHODS

Plant Material

The corms of two edible aroids *i.e.*, Giant taro and Elephant foot yam were procured from the farmers, growing them traditionally, in Himachal Pradesh, India. Healthy corms having good quality were selected for the experimentation.

Physico-Chemical Analysis

Physical parameters

Three corms of each aroid were selected randomly for measuring their weight, length and diameter. The values for the above parameters were recorded per corm. The weight (g) was recorded using a digital weighing balance (Wanser Ltd., Chennai), whereas the length and diameter (mm) of the corms were measured using a vernier caliper. Both the peel and pulp (remaining part of the corm, after removing the peel) weight were measured for the individual corms of both the types of aroids was measured. The pulp : peel ratio was determined using the formula:

$$\text{Pulp : peel ratio} = \frac{\text{Weight of pulp}}{\text{Weight of peel}}$$

Total soluble solids (TSS)

The TSS of the corm extract of both the aroids was determined after the preparation of corm extract 0.1 g/ml. The drops of corm extract were placed on the hand-held refractometer (MA871 digital refractometer, Milwaukee, Europe). The TSS were recorded and expressed as degree Brix (°B).

Moisture content

The corms of two aroids were cut into small pieces after removing their peel. Moisture content of the fresh corms was determined by drying these small pieces (of known fresh weight) in a hot air oven (Popular Traders, Ambala Cantt.) at 50°C, until they attained a constant weight. Loss in the weight of the corm pieces after drying represented the moisture loss. Therefore, the percent moisture content of corms was calculated using the formula:

$$\text{Moisture (\%)} = \frac{\text{Weight of fresh corms} - \text{Weight of dried corms}}{\text{Weight of fresh corms}} \times 100$$

Antioxidant Activity

DPPH radical scavenging activity

The free radical scavenging activity of both the aroids was estimated using DPPH method [52]. The 0.1 mM solution of 1, 1-diphenly-2-pierylhydrazyl (DPPH) was prepared in methanol. One ml of the DPPH solution was added to each of the 3ml of 95% methanol extracts of the corms of two aroid species (in five replicates). The 3ml of 95% methanol was used instead of the corm extracts as control. The mixture was mixed vigorously using a vortex mixer (Spinix-vortex shaker, Tarsons Ltd., Kolkata) and then kept at the room temperature for 1 hour. After one hour of incubation at room temperature, its absorbance was recorded at 517 nm using a Single Beam UV-Visible spectrophotometer (Visiscan 167, Systronics India Ltd., Ahmedabad). The lesser absorbance of the reaction mixture was corresponding to a higher free radical scavenging activity. For both the aroids, the percent (%) DPPH scavenging activity was calculated using the following formula:

$$\text{DPPH scavenging activity (\%)} = 1 - \left[\frac{A_{control} - A_{sample}}{A_{control}}\right] \times 100$$

where, $A_{control}$ is the absorbance of the DPPH radical in methanol, A_{sample} is the absorbance of the DPPH radical solution mixed with the sample.

Total phenolic content

Total phenolic content (TPC) of the corms were measured using the method of [53] with slight modifications. The 100 µl of each corm extracts (1 g/ml) was mixed with 2 ml of 2 % (w/v) Sodium carbonate solution. After 3 minutes, 100 µl of 50 % (v/v) Folin-ciocalteu's (FC) reagent was added to the above mixture. Samples were then kept in dark at the room temperature for 1 hour. Absorbance was measured at 750 nm against blank (95% methanol in place of the corm extract) using the spectrophotometer. TPC was calculated, based on the calibration curve of a standard phenolic compound *i.e.*, gallic acid and the TPC was presented in terms of gallic acid equivalents per g of the corm extract.

Total flavonoid content

Total flavonoid content (TFC) of the corm extracts was determined by the method given by AbouZid and Elsherbeiny [54]. The 100µl of each corm extracts (1g/ml) was placed in a 10 ml flask and 5 ml of distilled water was added. Thereafter, 0.3 ml of 5% Sodium nitrite was added into it. After 5 minutes, 0.6 ml of 10% Aluminum chloride (w/v) was added to each flask. After another 5 minutes, 2 ml of 1M Sodium hydroxide (w/v) was added and the volume was made 10 ml by adding distilled water. The solution was mixed well and incubated for 1 hour in dark at the room temperature. After one hour the absorbance was recorded at 510 nm using the spectrophotometer. The TFC was calculated using the calibration curve of a standard flavonoid compound *i.e.*, catechin and the TFC was presented in terms of catechin equivalent per g of the corm extract.

Ascorbic acid

The ascorbic acid was determined using 2, 6-dichlorophenol indophenol titration method given by Ranganna [55]. The 10 ml of each corm extract was mixed with 3 % (w/v) metaphosphoric acid to make the volume 100 ml and the resultant mixture was filtered using a Whatman's no 1 filter paper. The filtrate was then titrated with the dye (2, 6-dichlorophenol indophenol) until the light pink colour persists for at least 15 seconds. The dye was standardized by titrating against standard ascorbic acid solution (0.1 mg L- ascorbic acid per ml of 3% metaphosphoric acid and the dye factor) was calculated from the formula given below:

$$\text{Dye factor} = \frac{0.5}{\text{Titre value}}$$

The results were expressed as (mg/100g) of sample and was estimated using the formula:

$$\text{Ascorbic acid} = \frac{\text{Titre} \times \text{dye factor} \times \text{volume made up}}{\text{Aliquot of extract taken} \times \text{weight of sample}} \times 100$$

Preparation of Pickles

The outer peel of the corms was removed and the remaining part was cut into the small uniform pieces. These pieces were then kept in boiling water-bath (Serological water bath, Popular Trades, Ambala) for about 15 minutes before the preparation of the pickle. 600 g of the corm pieces for both the aroids were put into the brine solution of 10% edible salt having 200 ppm of $CaCl_2$ for a period of 5 days for both the types of pickles (oil based and dry) from both the aroids (Table 1). Besides the ingredients listed in Table 1, some other constituents used in the pickles (both the dry and oil based) were 8% chili powder, 5% coriander powder, 4% roasted mustard seeds, 2% fenugreek powder and 1% turmeric powder.

Table-1: Ingredients for oil based and dry pickle of the corms

S. No.	Pickle type	Amount of corm cubes (g)	Salt (%)	Mustard oil (%)	$CaCl_2$ (ppm)
1.	Oil based	600	12	25	2000 ppm
2.	Dry	600	12	-	2000 ppm

Organoleptic Evaluation

The pickles were evaluated based on their sensory scores by the panel of 5 judges during the 90 days of storage period (*i.e.*, after 0, 30, 60, 90 days). Evaluation was made independently for the different parameters taste, appearance, aroma and flavour, acridity and overall acceptability on a 9-point hedonic scale following numerical rating method [56]. Performa used for evaluating the pickle. The highest point 9 shows that the product is extremely liked and the lowest point 1 shows that the product is least liked.

Storage Stability of the Pickles

For assessing the storage stability of the pickles, they were subjected to evaluation fresh (0 days) and after 90 days of storage period for characters like shriveling, colour change, softness and scum formation.

Statistical Analysis

For assessing the physico-chemical parameters for the corms of the two aroids, the data was expressed as mean ± standard error of three independent replicates. Whereas, for the study of antioxidant properties, the data was expressed as mean ± standard error of five independent replicates. The difference in the mean values of the physico-chemical and antioxidant properties, paired sample t-test (Student's t) was performed at 5% level of significance ($p \le 0.05$). For the pickles of the two aroids, the mean organoleptic scores were recorded over a storage period of 90 days at 30 days interval (*i.e.*, 0 days, 30 days, 60 days and 90 days). To evaluate the effect of storage period, effect of treatments (corm type and storage period) and their interactions in affecting organoleptic parameters, two way analysis (ANOVA) was performed in a factorial (two factor) completely randomized design (CRD) at 5% level of

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significance ($p \leq 0.05$). The critical difference (CD) was calculated using Fisher's Least Significant Difference (LSD) method at 5% level of significance ($p \leq 0.05$).

II. RESULTS

In the present investigation the corms of two edible aroids *viz*., Elephant foot yam (Zimikand) and Giant taro (Ghandiyali), were compared in terms of their antioxidant potential and the organoleptic acceptability of their pickles. After procuring the fresh corms of these two aroids, first their physico-chemical characteristics were compared as presented below.

Physico-Chemical Analysis

The observations recorded for the physico-chemical parameters of the corms of two edible aroids (Elephant foot yam and Giant taro) *viz.,* flesh colour, height, diameter, weight, pulp to peel ratio, moisture content and total soluble solids (TSS) are listed in Table 2.

Table 2: Physico-chemical parameters of Elephant foot yam and Giant taro corms

Parameters	Elephant foot yam (Zimikand)	Giant taro (Ghandiyali)
Flesh colour	Pinkish-yellow	White
Height (cm)#	11.10±2.27	27.13±7.24
Diameter (cm)#	13.22±1.40*	6.48±0.86
Weight (g)#	851.6±217.52*	590.26±226.34
Pulp to peel ratio#	10.31±0.78	10.26±2.62
Moisture content (%)#	75.48±1.74	78.91±0.57
TSS (°B) of corm juice#	5.70±0.03*	4.70±0.04

#Values are represented as Mean ± Standard error n=3
*Values are significantly different at $p \leq 0.05$ (paired sample t-test)

The flesh colour of the elephant foot yam was recorded as pinkish-yellow whereas of giant taro was recorded as white. The mean height, diameter, weight, pulp to peel ratio, moisture content and TSS of the elephant foot yam corms were recorded as 11.10±2.27 cm, 13.22±1.40 cm, 851.6±217.52 g, 10.31±0.78, 75.48±1.74 %, 5.7±0.03 °B respectively. Whereas, the mean height, diameter, weight, pulp to peel ratio, moisture content and total soluble solids of the giant taro corms were recorded as 27.13±7.24 cm, 6.48±0.86 cm, 590.26±226.34 g, 10.26±2.62, 78.91±0.57 % and 4.7±0.038 °B respectively. The TSS, weight and diameter of the corms of elephant foot yam were found to be significantly higher than that of giant taro (paired sample t-test, $p \leq 0.05$).

Antioxidant Properties

The antioxidant potentials of the two aroids were compared in terms of their DPPH radical scavenging activity, total phenolic content, total flavonoid content and ascorbic acid content as presented below.

DPPH Radical scavenging activity

The DPPH radical scavenging activity of the corm extracts showed that giant taro is having higher free radical scavenging activity than elephant foot yam. The DPPH radical scavenging activity of the giant taro corm extract was 78.20±1.48 %, which was significantly higher (paired sample t-test, $p \leq 0.05$) than that of elephant foot yam corm extract *i.e.*, 64.69±1.42 % (Figure 1a).

Total phenolic content

It was found that the extract of giant taro corm was having about 2.6 times more than total phenolic content (TPC) than that of elephant foot yam. The TPC of the giant taro extract was recorded as 76.16±2.10 mg/g of corm fresh weight which was significantly higher than the TPC of elephant foot yam extract, which was recorded as 29.29±1.05 mg/g of corm fresh weight in terms of gallic acid equivalents (Figure 1b).

Total flavonoid content

The total flavonoid content (TFC) of the giant taro corm extract was about 9.57 folds higher than the elephant foot yam corm extract. The TFC of giant taro extract was recorded as 62.23±3.80 mg/g of corm fresh weight, which was significantly higher than that of the elephant foot yam which was recorded to be 6.50±1.66 mg/g of corm fresh weight in terms of catechin equivalents (Figure 1c).

Ascorbic acid content

The ascorbic acid content of the giant taro corm extract was found about 1.7 times higher than that of elephant foot yam. The ascorbic acid content of giant taro extract was observed to be 0.12±0.0037 mg/g of corm fresh weight, which was significantly higher than that of elephant foot yam which was recorded to be 0.07±0.003 mg/g of corm fresh weight (Figure 1d).

Figure 1: Comparison of antioxidant properties of the two aroids in terms of a.) DPPH radical inhibition activity b.) Total phenolic content c.) Total flavonoid content d.) Ascorbic acid content
*Values are significantly different at $p \leq 0.05$ (paired sample t-test)

Table 3: Changes in the taste of both the dry and oil pickles during storage

		DRY PICKLE			
	0	**30**	**60**	**90**	**Mean**
Elephant foot yam	5.93	6.36	6.83	7.46	6.65
Giant taro	5.93	6.53	6.96	7.60	6.75
Mean	5.93	6.45	6.90	7.53	
	F test		**SEm±**		**C.D.**
Corms (A)	NS		0.05		N/A
Storage period (B)	*		0.08		0.25

A×B	NS	0.11	N/A	

OIL PICKLE					
	0	30	60	90	Mean
Elephant foot yam	6.26	6.83	7.33	8.03	7.11
Giant taro	6.56	6.96	7.70	8.40	7.40
Mean	6.41	6.90	7.51	8.21	
	F test		SEm±		C.D.
Corms (A)	*		0.06		0.19
Storage period (B)	*		0.09		0.27
A×B	NS		0.13		N/A

*F-test is significant at 5% level of significance ($p \leq 0.05$)
NSF-test is not significant at 5% level of significance ($p \leq 0.05$)
N/ACD (at 5%) was not calculated because the F-test was not found significant

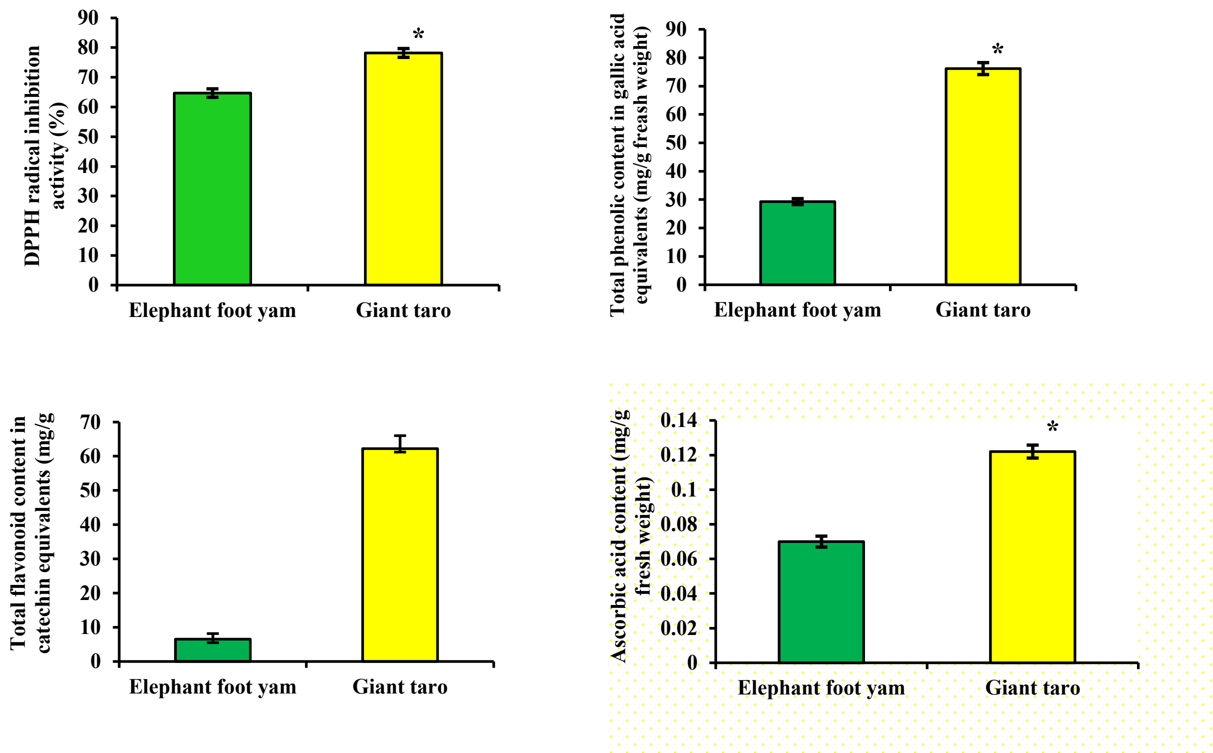

Figure 1: Comparison of antioxidant properties of the two aroids in terms of a.) DPPH radical inhibition activity b.) Total phenolic content c.) Total flavonoid content d.) Ascorbic acid content
*Values are significantly different at p≤0.05 (paired sample t-test)

Organoleptic Evaluation of the Pickles

The dry as well as oil pickles of both elephant foot yam and giant taro corms were compared on the basis of independent organoleptic evaluation by a panel of 5 judges, soon after the preparation (on day 0) and after a storage period of 90 days, based on their taste, appearance, aroma and flavour, acridity as well as the overall acceptability on a 9-point hedonic scale, as presented below.

Taste

It was found that among the dry pickles of two aroids, the taste changed significantly along the storage period (Table 3), whereas the change in the taste of pickle among the two aroids (giant taro and elephant foot yam) was found to be statistically non-significant (F- test, $P \leq 0.05$). Further, their interaction (corms and the storage period) was also non-significant.

A similar taste score of 5.93 was found in both the dry pickles of the corms which improved significantly to the 7.46 and 7.60 after the 90 days of storage period in elephant foot yam and giant taro respectively. The taste of the oil pickle changed significantly among the two aroids and also along the storage period (Table 3).

However, their interaction effect was found to be non-significant. The taste score of giant taro pickle (6.56) was found better than the elephant foot yam pickle (6.26) which increased to 8.40 and 8.03 after the storage period (90 days) respectively. Moreover, oil pickles were having the better taste score than the dry pickles. Overall, the highest taste score was recorded in giant taro oil pickle *i.e.*, 8.40, after 90 days of storage period (Table 3).

Appearance

The appearance scores of the dry pickles changed significantly during the storage period and also among the two aroids (Table 4). Whereas, the interaction effect between them was found to be non-significant. An appearance score of 8.43 was recorded for giant taro dry pickle that was better than that of elephant foot yam (7.50). Further, the appearance scores of both the dry pickles reduced to 6.63 and 6.03 respectively, after the storage period of 90 days.

Appearance scores of the oil pickles changed significantly during the storage period and also among the aroids (Table 4). Whereas, the interaction effect between them was found to be non-significant. The appearance score of giant taro oil pickle was recorded as 8.83 which was more than that of elephant foot yam *i.e.*, 7.80.

However, the appearance scores of both the pickles were reduced to 7.30 and 6.36 respectively, after the storage period. Overall, a better appearance score was recorded in the oil pickles than the dry pickles and the maximum appearance score was found in giant taro oil pickle *i.e.*, 7.30, after 90 days of storage period (Table 4).

Table 4: Changes in the appearance of both the dry and oil pickles during storage

DRY PICKLE					
	0	**30**	**60**	**90**	**Mean**
Elephant foot yam	7.50	6.93	6.36	6.03	6.70
Giant taro	8.43	7.76	7.20	6.63	7.50
Mean	7.96	7.35	6.78	6.33	
	F test		**SEm±**		**C.D.**
Corms (A)	*		0.06		0.20
Storage period (B)	*		0.09		0.29
A×B	NS		0.13		N/A
OIL PICKLE					
	0	**30**	**60**	**90**	**Mean**
Elephant foot yam	7.80	7.33	7.10	6.36	7.15
Giant taro	8.83	8.36	8.1	7.30	8.15
Mean	8.31	7.85	7.6	6.83	
	F test		**SEm±**		**C.D.**
Corms (A)	*		0.06		0.20
Storage period (B)	*		0.09		0.28
A×B	NS		0.13		N/A

*F-test is significant at 5% level of significance ($p \leq 0.05$)
[NS]F-test is not significant at 5% level of significance ($p \leq 0.05$)
[N/A]CD (at 5%) was not calculated because the F-test was not found significant

Table 5: Changes in the acridity of both the dry and oil pickles during the storage

DRY PICKLE					
	0	**30**	**60**	**90**	**Mean**
Elephant foot yam	7.86	6.90	6.06	5.40	6.55
Giant taro	7.60	6.66	5.73	4.90	6.22
Mean	7.73	6.78	5.9	5.15	
	F test		**SEm±**		**C.D.**
Corms (A)	*		0.09		0.27
Storage period (B)	*		0.12		0.39
A×B	NS		0.18		N/A
OIL PICKLE					
	0	**30**	**60**	**90**	**Mean**
Elephant foot yam	7.63	6.66	6.03	5.30	6.40
Giant taro	7.33	6.33	5.46	4.73	5.96
Mean	7.48	6.50	5.75	5.01	
	F test		**SEm±**		**C.D.**
Corms (A)	*		0.09		0.27
Storage period (B)	*		0.12		0.38

A×B	NS	0.18	N/A

*F-test is significant at 5% level of significance (p ≤ 0.05)
[NS]F-test is not significant at 5% level of significance (p ≤ 0.05)
[N/A]CD (at 5%) was not calculated because the F-test was not found significant

Acridity

The acridity scores of dry pickles changed significantly along the storage period and among the two aroids (Table 5). However, the interaction effect of them was found to be non-significant. Further, the higher acridity score was found in the elephant foot yam dry pickle (7.86) than giant taro dry pickle (7.60) which reduced to 5.40 and 4.90 respectively, after 90 days of storage period (Table 5). Acridity scores in case of the oil pickles changed significantly during the storage period and also among the two aroids. Further, the interaction effect between them was found to be non-significant. The acridity score of elephant foot yam was 7.63, that was higher than that of giant taro oil pickle *i.e.*, 7.33. However, it was reduced to 5.30 and 4.73 respectively, after the storage period. Moreover, the higher acridity score was recorded in the dry pickles than that of oil pickles and overall the giant taro oil pickle was recorded to have the lowest acridity score *i.e.*, 4.73, after 90 days of storage period (Table 5).

Aroma and Flavour

The aroma and flavour scores of the dry pickles changed significantly during the storage period and among the two aroids (Table 6). Whereas, the interaction effect of them was found to be non-significant. A higher aroma and flavour score of 8.43 was recorded in the dry pickle of giant taro than that of elephant foot yam *i.e.*, 7.43, which was reduced to 6.70 and 5.76 respectively, after the 90 days of storage period.

The aroma and flavour scores of the oil pickles changed significantly along with the storage period and also among the two aroids. A higher aroma and flavour score of 8.53 was recorded in the giant taro pickle than that of elephant foot yam *i.e.*, 8.33, which reduced to 6.86 and 6.23 respectively, after the storage period (Table 6). Moreover, a higher aroma and flavour score was recorded in oil pickles than the dry pickles and overall the giant taro oil pickle has the highest aroma and flavour score among the pickles *i.e.*, 6.86, after 90 days of storage period.

Table 6: Changes in the aroma and flavour of both the dry and oil pickles during storage

			DRY PICKLE		
	0	**30**	**60**	**90**	**Mean**
Elephant foot yam	7.43	6.93	6.33	5.76	6.61
Giant taro	8.43	8.03	7.26	6.70	7.60
Mean	7.93	7.48	6.80	6.23	
	F test		**SEm±**		**C.D.**
Corms (A)	*		0.08		0.25
Storage period (B)	*		0.11		0.36
A×B	NS		0.16		N/A
			OIL PICKLE		
	0	**30**	**60**	**90**	**Mean**
Elephant foot yam	8.33	7.50	7.06	6.23	7.28
Giant taro	8.53	7.93	7.26	6.86	7.65
Mean	8.43	7.71	7.16	6.55	
	F test		**SEm±**		**C.D.**
Corms (A)	*		0.07		0.21
Storage period (B)	*		0.09		0.30
A×B	NS		0.14		N/A

*F-test is significant at 5% level of significance (p ≤ 0.05)
[NS]F-test is not significant at 5% level of significance (p ≤ 0.05)
[N/A]CD (at 5%) was not calculated because the F-test was not found significant

Table 7: Changes in the overall acceptability of both the dry and oil pickles during storage

			DRY PICKLE		
	0	**30**	**60**	**90**	**Mean**
Elephant foot yam	7.50	6.76	6.06	5.50	6.45
Giant taro	7.86	7.56	7.20	6.73	7.34
Mean	7.68	7.16	6.63	6.11	
	F test		**SEm±**		**C.D.**
Corms (A)	*		0.07		0.22
Storage period (B)	*		0.10		0.32
A×B	*		0.15		0.45
			OIL PICKLE		
	0	**30**	**60**	**90**	**Mean**

Elephant foot yam	7.93	7.23	6.76	6.30	7.05
Giant taro	8.33	7.83	7.43	6.76	7.59
Mean	8.13	7.53	7.10	6.53	

	F test	SEm±	C.D.
Corms (A)	*	0.06	0.18
Storage period (B)	*	0.08	0.25
A×B	NS	0.12	N/A

*F-test is significant at 5% level of significance ($p \leq 0.05$)
NSF-test is not significant at 5% level of significance ($p \leq 0.05$)
N/ACD (at 5%) was not calculated because the F-test was not found significant

Table 8: The scale used for rating qualitative characteristics of pickles

Shriveling	Colour Change	Softness	Scum formation	Score
Not recorded	Retained original colour	Not recorded	Not recorded	2
Partial	Slight change	Slight	Little	1
More	Complete change	Complete	More	0

Table 9: Change in qualitative characters of elephant foot yam and giant taro oil pickles during storage

Treatments	Qualitative Characters							
	Shriveling		Colour change		Softness		Scum formation	
	I	II	I	II	I	II	I	II
Elephant foot yam oil pickle	2	2	2	1	2	1	2	2
Giant taro oil pickle	2	2	2	2	2	1	2	2

Note:
I- Soon after preparation
II- After 90 days

Table 10: Change in qualitative characters of elephant foot yam and giant taro dry pickles during storage

Treatments	Qualitative Characters							
	Shrivelling		Colour change		Softness		Scum formation	
	I	II	I	II	I	II	I	II
Elephant foot yam salt pickle	2	0	2	1	2	2	2	1
Giant taro salt pickle	2	1	2	2	2	2	2	2

Note:
I- Soon after preparation
II- After 90 days

Overall Acceptability

The overall acceptability scores of the dry pickles changed significantly along the storage period, among the corms as well as in the interaction effect between them (Table 7). The higher overall acceptability score of 7.86 was recorded in dry pickle of giant taro than that of elephant foot yam *i.e.*, 7.50, which reduced to 6.73 and 5.50 respectively, after the storage period. Further, the overall acceptability scores of the oil pickles changed significantly during the storage period and among the corms.

Whereas, the interaction effect in them was found to be non-significant. The higher overall acceptability score of 8.33 was recorded in giant taro pickle than that of elephant foot yam pickle *i.e.*, 7.93 which reduced to 6.76 and 6.30 respectively, after the storage period (Table 7). However, the higher score in overall acceptability was recorded in the oil pickles than the dry pickles and overall the giant taro oil pickle has the highest overall acceptability score among the pickles *i.e.*, 6.76, after 90 days of storage period (Table 7).

Storage Stability

The assessment of the qualities like shrivelling, colour change, softness and scum formation in both the oil and dry pickles, was made soon after the preparation (day 0) and also after the storage period (90 days). The scale used for the rating of qualitative characters is presented in Table 8; whereas the results of the qualitative characters of dry pickles and oil pickles are presented in Table 9, and Table 10 respectively.

After the storage period, the elephant foot yam and giant taro oil pickles were found free from any shrivelling and scum formation. A slight change in the colour of elephant foot yam oil pickles was noticed, whereas the giant taro oil pickles retained their original colour. Slight softening was observed in both the elephant foot yam oil pickles and giant taro oil pickles (Table 9).

For dry pickles of both the corms (elephant foot yam and giant taro), more shrivelling was noticed in the elephant foot yam dry pickle, whereas partial shriveling was noticed in giant taro dry pickle. There was slight change in the colour of elephant foot yam dry pickles and in giant taro pickles no changes in the colour was recorded. Slight softening was

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recorded in the pickles of both the corms no scum formation was noticed after the storage period of 90 days (Table 9).

Changes in the qualitative characteristics of the pickles during storage period

The qualitative characteristics of all the four types of pickles (dry pickle of elephant foot yam, dry pickle of giant taro, oil pickle of elephant foot yam and oil pickle of giant taro) were compared in freshly prepared (day 0) pickles vis-à-vis after the storage period (day 90), in terms of quality attributes *i.e.*, taste, aroma and flavour, appearance, acridity and overall acceptability using the web-type graphs (Figure 2).

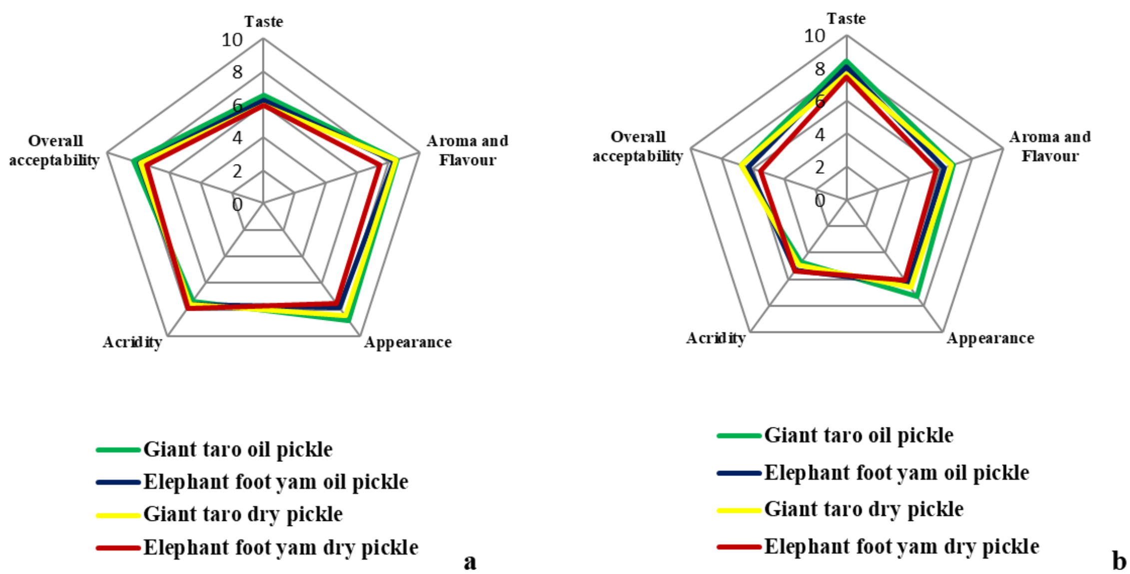

Figure 2: Organoleptic evaluation of the pickles a.) soon after preparation (0 day) b.) after 90 days of storage period

Taste

The taste score of all the pickles improved significantly after 90 days of the storage period. Among the four pickle recipes tried, taste score of giant taro oil pickle was recorded to be highest (6.56) soon after the preparation (day 0), which further increased to 8.40 after 90 days of storage. Its taste score remained highest even after the storage period. However, the taste score of dry pickle of elephant foot yam was lowest (5.93), which increased to the 7.46 after 90 days of storage.

Appearance

The appearance score of all the pickles decreased significantly during storage period. Appearance score of giant taro oil pickle was recorded highest (8.83) soon after preparation (day 0), which further reduced to (7.30) after 90 days of storage period. The appearance score of giant taro oil pickle remained highest among the four pickle recipes tried after the storage period (90 days), although there was a decline in trend of appearance score during storage. However, the appearance score of elephant foot yam dry pickle was lowest (7.50) which remains lowest (6.03) after the storage period.

Acridity

Acridity in all the pickles reduced with the passage of time as reflected by a significant decrease in the acridity scores which decreased significantly after 90 days of storage period. The acridity score of giant taro oil pickle was at least (7.33) soon after preparation (day 0), which remained at least (4.73) after 90 days of storage period. The acridity score of giant taro oil pickle remained at lowest among the four pickle recipes, even after the storage period. The acridity of the elephant foot yam dry pickle was recorded highest (7.86) soon after preparation (day 0), which later reduced to 5.40, after 90 days of storage.

Aroma and Flavour

The aroma and flavour score of all the pickles decreased significantly after 90 days of storage period. The aroma and flavour score giant taro oil pickle was recorded highest (8.53) soon after preparation (days 0), which reduced to 6.86 after 90 days of storage period. Its aroma and flavour score remained highest even after the storage period. However, the aroma and flavour score of elephant foot yam dry pickle was lowest (7.43) soon after preparation, which remained lowest (5.76) even after the storage period.

Overall Acceptability

In overall acceptability score of all the pickles decreased significantly after 90 days of storage period. The overall acceptability score of the giant taro oil pickle was recorded highest (8.33) soon after preparation (day 0), which reduced to the 6.76 after 90 days of storage period. The giant taro oil pickle score remained highest, even after the storage period. However, the overall acceptability score of the elephant foot yam dry pickle was lowest (7.50) soon after preparation (day 0), which remained lowest (5.50) after the storage period.

III. DISCUSSION

Nutritious diet is essential for living a healthy life. The antioxidants are naturally present in various food stuffs and may help in the prevention of human ailments and delaying aging by checking the steady state levels of reactive oxygen species (ROS), which may harm our body if left unchecked. Thus, the intake of dietary antioxidants helps in maintenance of health and prevention of many diseases. The dietary antioxidants are found in vegetables and fruits in adequate amounts naturally. Therefore, people around the world are consuming a wide range of vegetables in both cooked and raw form to gain the dietary benefits.

The edible aroids are known to possess strong antioxidant properties due to the presence of phenolic compounds [57]. Therefore, they are the dietary source of interest for producing functional food products by the food manufacturing industry. Further, the edible aroids are generally seasonal crops and their consistent availability around the year is not possible because of their shorter shelf life without storage. To maintain their year around availability and to increase their shelf life, edible aroids can be processed into various value added products like pickles, papad, cakes, chutney *etc*. Also, it has been observed that due to the changing lifestyles, it is difficult to find enough time for the preparation of the meals. Thus, there is gradual shift in consumer's choice from raw to processed or semi-processed foodstuffs. Further, is an increasing demand of processed/semi-processed these days. The preparation of ready to eat, processed food products not only increases the shelf life of the perishable commodities, but also ensure their round the year availability in the form of value-added products thereof.

In the present study, the physico-chemical composition of the aroids (*viz.*, elephant foot yam and giant taro) was recorded before assessing their antioxidant properties and the optimization of recipes for their pickles.

Physico-Chemical Parameters

A high degree of morphological variability exists among the edible aroids. Variability was noticed in the morphological characters like corm shape as well as the colour of corm flesh of the 17 genotypes (wild and cultivated) of elephant foot yam (*A. paeoniifolius* syn. *A. campanulatus*). The shape of the corms was recorded from sub-globose, flat-globose, depressed-globose, saucer-shaped, vertically elongated to irregularly sub-globose; whereas the corm surface was recorded as rough to smooth. The colour of the corms flesh was also found variable (recorded as pale greenish yellow, light-yellow green, light yellow to yellowish white) [58]. For the present study, the corms of elephant foot yam (*A. paeoniifolius*) were procured from the local market, which were characterized by rough surface, depressed globose to irregular shape, dark brown colour of outer surface and light yellow to light pink colour of inner surface.

In a study by Jansen *et al*. [16], it was noticed that different species of *Amorphophallus*, collectively referred as elephant foot yams have variable morphological characters. The *A. muelleri* corms are dark brown from outside and yellow from inside, whereas *A. paeoniifolius* are dark brown from outside; however *A.konjac* corms are brown from outside. The shape and colour of the two varieties of *A. paeoniifolius*, NDA 5 and NDA 9 were recorded as brown and irregular respectively [59].

In the present study the height, diameter, weight, pulp to peel ratio, moisture content and TSS of the elephant foot yam corms was recorded as 11.1±2.27 cm, 132.24±14.03 cm, 851.6±217.52 g, 10.31±0.78, 75.48±1.74 % and 5.7±0.03 °B respectively. In a study on two different varieties of elephant foot yam *viz*., NDA 5 and NDA 9 the above parameters were also recorded, which were quite closer to our observations. The mean length, breadth, weight, peel percentage and moisture content of the variety NDA-5 were recorded to be 17 cm, 13 cm, 400 g, 17.80% and 77.50% respectively; whereas for NDA 9 they respective values were 18 cm, 13 cm, 430 g, 11.60% and 76.93% [59]. The small variation in the morphological characters of the corms could be attributed to the varietal characteristics as well the environmental conditions. Different species of *Amorphophallus* have different sizes of corms. Jansen *et al*. [16], reported that weight, diameter and length of *A. konjac* tubers were upto 10 kg, 30 cm and 20 cm; whereas the *A. paeoniifolius*, tubers were up to 25 kg, 30 cm and 20 cm and *A. variabilis* tubers were up to 1.5 kg, 15 cm and 8 cm respectively. Further, Vora *et al*. [60], reported that the moisture content of the elephant foot yam tubers was 70.535%, which is quite closer to the moisture content recorded during the present study.

In the present study, the shape of giant taro corms was recorded to be cylindrical. The outer surface of the corms was covered with of light-dark brown scales and the inner flesh colour was white. The colour of the giant taro was recorded as white [61], which was in agreement with the present study. In another study [62], the similar cylindrical shape corms in *Alocasia* spp. were recorded, however the colour of the corms used in their study was found to be pale green.

In the present study, height, diameter, weight, pulp to peel ratio, moisture content and TSS of the giant taro corms was recorded as 27.13±7.24 cm, 64.83±8.62 cm, 590.26±226.34 g, 10.26±2.62, 78.91±0.57% and 4.7±0.038 °B respectively. The variability in the morphological characters of wild *Alocasia macrorrhizos* was noticed in terms of length and diameter of the corms, which were in a range of 26.4-160.0 cm and 1.1-12.5 cm, respectively [63]. The variations in the size of corms among different species of *Alocasia* spp. have been recorded. The length and diameter of the *A. hypnosa* was recorded to be 10 cm and 13.5 cm respectively, whereas the same for *A. odora* were found to be 10-100 and 5-18 cm, respectively [62]. Further, some corms of *Alocasia* spp. have been recorded to be extraordinarily long. O' Hair and Maynard [64] reported that the edible portion (large semi-compressed stem) of some *Alocasia* spp. can reach up to 12 m in height, 6 cm in diameter with a weight of up to 18 kg. Further, the moisture content of the giant taro (*Alocasia* spp.) was recorded in a range of 71.92-86.50% by various workers [8, 61, 65]. The moisture content recorded during the present study (78.91±0.57%) falls within this range. The variation in the morphological characters of the giant taro corms may be because of the variation on varietal characteristics as well as the agro-climatic conditions.

Antioxidant Potential

There are a number of ways to determine antioxidant potential of a plant tissue/its extract. Out of these, DPPH radical scavenging activity, phenolic content, flavonoid content, reducing power assay, hydroxyl radical scavenging, nitric oxide radical scavenging, superoxide radical scavenging, superoxide dismutase activity (SOD), catalase activity, lipid Peroxidation *etc*. among the commonly used methods [25, 28, 31, 66-68]. In the present study the DPPH radical scavenging activity, total phenols, total flavonoids and total ascorbic acid content of the crude corm extracts of elephant foot yam and giant taro were analyzed.

The variations in the antioxidant properties have been noticed with plant part used tissues (*e.g.*, corms, leaves, roots or stems *etc*.) [27, 69-72]. Further among the aroids different genera, different species within a genus and various varieties/cultivars within a species may vary in terms of their antioxidant potential [73, 74]. Moreover, various fractions/extracts (based on various solvents used for the extraction of antioxidants) *i.e*., methanol extract, ethanol extract, petroleum ether extract, aqueous extract *etc*. of the aroids and the extraction procedure may also influence the antioxidant activities [24, 28, 75]. In the present study the methanolic extract both the aroids was used to evaluate their antioxidant potential.

DPPH Radical scavenging activity

The results in the present study revealed that the crude methanol extract of the giant taro corm extract (78.20±1.48%) had higher DPPH free radical scavenging activity as compared to elephant foot yam extract (64.69±1.42%). Selvakumar *et al.* [69], reported that in the ethanolic extract of the plant parts, the percent inhibition activity of the leaf extract was found maximum (70.00±0.15%) followed by stem extract (62.55±0.25%) and root extract (48.44±0.38%) at 500 µg/ml concentration. In another study, the DPPH radical scavenging activity of different extracts of *Alocasia macrorrhizos* were determined at different concentrations from 62.5-500 µg/ml for different solvent extracts *viz.*, methanolic crude extract, carbon tetrachloride extract, petroleum ether extract, chloroform extract and aqueous extract. Out of these extracts, the crude methanolic extract was found to have the maximum percent DPPH inhibition activity from 64.48-78.81%, than the other solvents [24].

In a study by Bais *et al.* [75], the DPPH radical scavenging activity of the dried corm powder of *A. campanulatus* of different extracts *viz*., methanolic extract, ethanol extract, acetone (70%) extract and hydroalcohol (70%) extract from which the methanolic extract of the corm was found to have the highest DPPH radical-scavenging activity. However, in another study the DPPH radical scavenging activity of the methanolic and ethanolic extracts of the tuber of *A. campanulatus* was obtained as 50.31±0.52 and 61.1±1.56% inhibition at 100 µg/ml concentration [28].

In an experiment conducted by Jain *et al*. [76], the DPPH radical scavenging activity of the ethanolic extract of the *A. campanulatus* corms was recorded at the 100-1000 µg/ml concentrations. The DPPH inhibition activity was recorded in the range of 2.09±0.89 to 74.25±1.13% at 100-1000 µg/ml concentrations respectively. However, at 500 µg/ml concentration the DPPH inhibition was determined as 37.54±1.65%. Further, Angayarkanni *et al*. [26], recorded that the ethanolic extract *A. paeoniifolius* tubers have the DPPH scavenging activity of 68.6% at 50 µg/ml concentration.

Total Phenolic Content

In the present study, the methanolic extract of the corms of giant taro have higher total phenolic content (76.16±2.10 mg/g fresh weight) than that of elephant foot yam (29.29±1.05 mg/g fresh weight) in terms of gallic acid equivalents. Various other workers have also recorded the total phenol content in the corms of the various aroid species. Islam *et al.* [7], reported that the ethanolic extract of the dried tubers of *Alocasia indica* was found to be 542.26 mg/100g of dried corms/tubers in terms of gallic acid equivalents. It has also been recorded that the age of the plant or plant parts may also affect the total phenolic content in them. In an experiment to determine the total phenol content in different parts of the *A. commutatus* extracts revealed that the level of total phenols in the corms, young leaves and in mature leaves were 0.2 mg/g, 0.02 mg/g and 0.01 mg/g tissue, respectively [70]. In another study, Nataraj *et al.* [77], found that the methanol extract of the tuber of the *A. paeoniifolius* contained 12.67 mg/g of the total phenols in terms of catechol equivalents. Basu *et al.* [73] determined that the total phenolic content of the ethanolic extract of the *A. campanulatus* is 190.42±2.2 mg/g w/w, *A. indica* 87.54±1.3 mg/g w/w and *Colocasia esculenta* 66.25±1.5 mg/g w/w with gallic acid equivalent/mg of dry weight sample.

Total Flavonoid Content

The flavonoid content of the giant taro was recorded as 62.23±3.80 mg/g fresh weight which was higher than that of elephant foot yam tuber extract 6.50±1.66 mg/g fresh weight in terms of catechin equivalents. In a study, Islam *et al.* [7], detected the ethanolic dried extract of the tubers of *A. indica* was recorded as 4.30 mg/g in terms of quercetin equivalents. In another study, the flavonoid content in the methanol extract and 70% hydroalcholic extract of the tubers of elephant foot yam was observed as 2.04 mg/ml and 2.84 mg/ml respectively in terms of rutin equivalents [77]. Further, Basu *et al*. [73], reported the total flavonoid content of the ethanolic extract of the *A. campanulatus, A. indica* and *C. esculenta* as 6.23±0.3 mg/g, 3.5±0.58 mg/g and 1.48±0.87 mg/g (w/w) respectively in terms of rutin equivalents per gram dry weight of the corm. The methanolic extract of the elephant foot yam was found to have more flavonoid content than the n-hexane extract. In a study by Ansil *et al.* [78], it was found that the flavonoid content in the methanolic extract of the tubers of the *A. campanulatus* was 5.20±0.80 mg/g dry extract and in its *n-hexane* extract it was 0.53±0.20 mg/g dry extract, in terms of quercetin equivalent.

Ascorbic Acid

The ascorbic acid content in the following research was observed as 0.12±0.004 mg/g for giant taro corm extract, which was higher than that of elephant foot yam corm extract (0.07±0.003 mg/g fresh weight). Different aroids have variable amount of ascorbic acid content in their tuber. It was recorded that the ascorbic acid content in the stems of different cultivars of *Colocasia* spp. and *Alocasia* spp. was determined in the rage of 30.80-33.53 mg/100g fresh weight and 21.16-28.56 mg/100g fresh weight respectively [74]. Karim *et al*. [71], obtained the ascorbic acid content of the leaf and stem of the *A. indica* as 23.53 mg/100g dry weight and 3.14 mg/100g dry weight respectively. Krishna *et al*. [70], obtained the ascorbic acid content in the tuber of *Amorphophallus commutatus* as 1.6 mg/g tissue, young leaves 1.9 mg/g tissue and matured leaves (1.3 mg/g tissue) respectively. Basu *et al*. [73], determined the ascorbic acid content in the tubers of the *A. campanulatus* as 76.65±10.5 mg/100g of dry weight. The ascorbic acid content in different cultivars may differ. It was found that the ascorbic acid content of BCA-4 was highest (2.93-1.27 mg/100g) *A. paeoniifolius* from different [79]. The variations in the ascorbic acid content within one aroid species as recorded in various studies, might be due to the variations in their varietal characteristics and the agro-climatic conditions.

Pickle Formation

The aroids are the rich source of dietary antioxidants mainly because of the presence of phenolics in them and have many nutraceutical properties [24, 57]. Therefore, they are the commodity of interest for the preparation of value added products. Further, due to their seasonal availability, they can be processed in the form of value added products for their year round consumption. Further, various edible parts of aroids are known to possess anti-nutritional factors like calcium oxalate crystals, also known as raphids, which leads to their acridity. However, various processing/cooking methods are used to reduce acridity in them [23, 80]. Due to this acridity, they cannot be consumed in raw/uncooked form. Therefore, making their value-added products is quite challenging. Different value-added products have been tried to reduce the acridity in the value-added products prepared form the edible aroids [18, 23, 81-83].

In the present study, the pickles from two edible aroids *i.e.*, *Alocasia* and *Amorphophallus* were prepared. They were also subjected to the organoleptic evaluation in terms of taste, appearance, aroma and flavour, acridity and overall acceptability. The taste score of the giant taro oil pickle (6.56) was found better than the other pickles which improved significantly (8.40) after the storage period. The appearance score of the giant taro oil pickle was highest (8.83) which remained at highest (7.30) than the other pickles recipes after the storage period. The aroma and flavour scores of the giant taro oil pickle was higher (8.53) which remained higher (6.86) than the other pickles even after the storage period. The overall acceptability score of the giant taro oil pickle was highest (8.33) which remained at highest (6.76) even after the storage period than the other pickle recipes. However, the least acridity was noticed in the giant taro oil pickle (7.33) which remained at least (4.73) even after the storage period of 90 days.

Some other workers have also tried the pickles from the edible aroids [72, 85-87, 89]. Taro (*C. esculenta*) pickle is among one of the traditional aroid pickles prepared in Himachal Pradesh [86]. Various methods used for acridity reduction in aroids include cooking, blanching, boiling, steaming, frying or stewing [23, 80]. One of the important methods used for acridity reduction in the natural lactic acid fermentation [88]. The reduction in acridity of pickles over the storage period (90 days) recorded in the present study, may be attributed to the phenomenon of slow natural fermentation taking place in the pickles during storage. Singh *et al*. [89], also tried the lactic fermentation in the pickles of two different cultivars of the elephant foot yam *viz.*, BCA-1 and IGMA-1.

From the present study, it was concluded that acridity in the pickles of aroids can be reduced after a storage period and the oil pickles of the aroids have lower acridity and better overall acceptability. Out of giant taro and elephant foot yam pickles, the acridity was lesser and the overall acceptability was better in giant taro pickles.

IV. CONCLUSION

The present work indicates that among these two aroids, the giant taro could have higher antioxidants than the elephant foot yam, therefore it is quite likely that value added products made from it could have higher amount antioxidants than that of elephant foot yam. Further, it was also concluded that the giant taro pickles have lesser acridity as well as higher overall acceptability than the elephant foot yam pickles. In the optimization of the recipes of the pickles, it was concluded that the oil-based pickle of giant taro was found to be better than its dry pickle.

Therefore, the present work is an attempt to optimize the recipe of the pickles in two aroid species, which are nutraceutically important, but are not processing friendly (due to the presence of acridity) and hence the preparation of value-added products is a challenging task in them. The present findings can help in scaling up of the process in an agro-based industry involved in the preparation of value-added products from aroids. These studies help the un-skilled/semi-skilled workers, unemployed youth, farm women or aspiring entrepreneurs can take up this task for their startups to generate rural employment/self-employment. These studies help in providing the vocational training to workers, unemployed youth, farm women and aspiring entrepreneurs, which can take up this task as their startups to generate rural employment/self-employment.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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