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Oxalate content in elephant foot yam (*Amorphophallus paeoniifolius* Dennst-Nicolson) Dry and Fry cubes

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Abstract
The presence of oxalate and acridity has led to gross underutilization of *Amorphophallus paeoniifolius*, a salubrious tuber, consumed traditionally as a vegetable. Therefore, as a means to overcome oxalate and acridity problem, treating the corms by alum and salt and then cooking resulted low oxalate content. Elephant foot yam significantly decreased ($p < 0.05$) the oxalate content, both soluble and insoluble. This study is totally based on qualitative and quantitative study of elephant foot yam corms during storage. On the basis of nutritional value two cultivars were used at maturity stage for making cubes and evaluated their oxalate content at 60 days intervals. The ranges of oxalate contents were found to be: water soluble oxalate 8.11-22.93 mg/100g, total soluble oxalate 10.01-28.51 mg/100g, calcium oxalate 0.63-9.38 mg/100g and total oxalate 10.86-31.04 mg/10g during storage. The mean soluble oxalate content was safe from the viewpoint of accumulation of urinary oxalate leading to kidney stones. Therefore, salt and alum treated tubers can certainly enhance its consumption pattern without any possible deleterious effect (renal functioning and mineral bioavailability) on human population. This information will provide scientist with the ability to develop quality product having high nutrition and better anti-nutritional profile.

Keywords: *Amorphophallus paeoniifolius,* cultivar, oxalate, dry cubes, fry cubes

Introduction

Elephant foot yam (*Amorphophallus paeoniifolius* Dennst-Nicolson) is locally used as a staple food in many Asian countries (Jansen *et al*. 1996) [1] and contributed both as tuber crops as well as vegetables to the diets of tribal people of India, particularly in rural areas where they are freely available (Singh *et al*. 2016) [2]. Among tropical aroid tuber crops, it's become popular due to high productivity in a short growing season and high net returns Rs. 140,000 to 175,000/ha (Mukhopadhyay and Sen 1999, Nath *et al*. 2007) [3, 4]. 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. Preparation of osmo-dehydrated slices from fresh corm (Singh and Wadhwa 2012) [5] and bread from flour of elephant foot yam corm, which is a good source of both carbohydrate and protein (Singh and Wadhwa 2014) [6]. These corms are consumed by many people as a food and widely used in many ayurvedic preparations (Angayarkanni *et al*. 2007) [7] because it contains different bioactive components like alkaloids, flavonoids, phenols, vitamins, minerals etc. (Bradbury and Holloway 1988, Chowdhury and Hussain 1979, Parkinson 1984, Sakai 1983, Yadu and Ajoy 2010) [8, 9, 10, 11, 12]. 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 (Yesodharan and Sujana 2000) [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 (Borah *et al*. 2008) [14].

The major problem associated with the consumption of elephant foot yam is its acridity and/or oxalate content. These factors deflected the usage of elephant foot yam as a food crop. Calcium oxalate present in fine crystals in elephant foot yam, which causes etching of fingers and pricking sensation of tongue and throat (Bradbury and Nixon 1998, Lewu *et al*. 2010) [15, 16]. Calcium oxalate (CaC_2O_4) is a major component of kidney stone, which high intake may reduce the calcium availability in the body and this may be an increased risk factor for women who require greater amount of calcium in their diets (Singh *et al*. 2018) [17]. Dietary oxalate has been known to complex with calcium, magnesium and iron leading to the formation of insoluble oxalate salt and resulting in oxalate stone (Onwuka 2005) [18]. Oxalates also interfere with the utilization of minerals making them unavailable or reduced in the body (Onwuka 2005; Singh *et al*. 2017) [18, 19]. Acridity is experienced as irritative (itching-stinging-burning) sensation in the mouth and throat, which may be followed by swelling. Its rubbing on external skin may also induce itching, thus pointing towards the intensity of irritation. The acridity is caused by needle like crystals of oxalate called raphides (Bradbury and Nixon 1998, Lewu *et al*. 2010) [15, 16]. Apart from acting as irritant, oxalate is considered to be anti-nutritional and toxic (Guil-Guerrero 2014) [20]. Ingestion of higher amount of oxalate (2 g) can be fatal to humans (Libert and Franceschi 1987) [21]. The crystals of oxalates can also get deposited in kidney and cause renal stones, leading to renal failure. About 75% of kidney stones are composed of oxalates and consumption of foods containing oxalate increase urinary oxalate content to variable extent (Williams and Wandzilak 1989) [22] is necessary to prevent oxalate related maladies (Massey *et al*. 1993) [23]. For patients with kidney stone, dietary intake of oxalates should be restricted to 40-50mg/day (ADA 2005, Chattopadhyay *et al*. 2009) [24, 25]. Therefore, removal of acridity/ oxalate will benefit in better utilization of Araceae plants for food and feed purposes. Selection of low acrid cultivar as well as by the treatment of alum and salt before boiling and cooking the tuber could be effective in alleviating the oxalates. This study is aimed at the evaluation of quantity and quality in elephant foot yam products *viz.* cubes, which may be important to reducing the levels of anti-nutrients in 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 oxalate content in cubes. Two cultivars (BCA-1 & IGAM-1) were selected on nutritional point of view at maturity stage, and after peeling it has sliced into suitable size of pieces (2.5X2.5X2.5cm) for preparing cubes with the help of knife. The pieces were treated by alum and salt at 1.5 and 2.0% concentration for 5 hrs. to develop firmness and check the oxidation process in cubes and then blanched (28 minutes at 7 kg/cm^2). After blanching dry the cubes at 55 ^{O}C temp for 6 hrs., then half of the cubes were fried in mustard oil for a minute and after cooling packed in polythene paper to check the variation in oxalate content at 60 days intervals.

Physico-chemical analysis

The oxalates contained of dry and fry cubes were analyze both years at sixty days intervals during storage by titrimetric methods (AOAC 1990, Holloway *et al*. 1989) [26, 27].

Statistical procedure

All the lab data were used to Complete Randomized Design (CRD) as suggested by Raghuramula (1983) [28]. 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.

Results and Discussion

There were variations in oxalate content in dry and fry cubes within the year of two selected cultivars that could be clinically important.

Water-soluble oxalate

Water-soluble oxalate (WSO) contents of dry and fry cubes prepared from elephant foot yam corm also varied significantly among the different treatments (Table-1). At the early stage of storage *i.e.,* at 0 days after storage (DAS), the cultivar BCA-1treated with salt @ 2.0 % and alum @ 1.5 % exhibited significantly higher mount of water soluble oxalate (22.93 and 20.72 mg/100g, respectively) fallowed by IGAM-1 with salt @ 1.5 % dry cubes, BCA-1 with alum @ 1.5 % fry cubes and IGAM-1 with alum @ 2.0 % dry cubes (18.95, 17.79 and 16.04 mg/100g, respectively), whereas significantly lowest WSO content was recorded in IGAM-1 treated with alum @ 2.0 % fry cubes, and salt 1.5 % fry cubes with values 12.93 and 15.42 mg/100g, respectively. At 360 days after storage maximum value (14.11 mg/100g) was recorded in BCA-1 treated with salt @ 2.0 % dry cubes which was *at par* with BCA-1 salt @ 2.0 % fry cubes, BCA-1 with alum @ 1.5 % dry cubes, BCA-1 alum @ 1.5 % fry cubes and IGAM-1 salt @ 1.5 % dry cubes (13.39, 13.25, 12.39 and 12.21 mg/100g, respectively). Minimum WSO content was found in IGAM-1 treated with salt @ 1.5 % fry cubes and treated with alum @ 2.0 % fry cubes (8.11 and 8.12). Taking all the storage stages into consideration, it was observed that there was significant variation in mean water-soluble oxalate content with the value ranging from 8.11 to 22.93 mg/100g. Oscaran and Savage (2007) [29] reported a similar finding in baked taro leaves and Kumar *et al*. (2017) [30] in elephant foot yam cubes.

Total soluble oxalate

Total soluble oxalate (TSO) content of dry and fry cubes were significantly influenced by treatment during storage (Table-2). The cultivar BCA-1 treated with salt @ 2.0 % dry cubes and treated with alum @1.5 % dry cubes contained highest amount (28.51 and 27.17 mg/100g, respectively) of TSO at 0 DAS, and the cultivar IGAM-1 treated with alum @ 2.0 % fry cubes and treated with salt @ 1.5 % fry cubes contained highest amount (17.28 and 20.47 mg/100g, respectively) of TSO at 0 DAS. While, BCA-1 treated with salt @ 2.0 % dry cubes and treated with alum @1.5 % dry cubes contained highest amount (17.24 and 16.16 mg/100g, respectively) of TSO at 360 DAS and the cultivar IGAM-1 treated with alum @ 2.0 % fry cubes and treated with salt @ 1.5 % fry cubes contained highest amount (10.01 and 11.27 mg/100g, respectively) of TSO at 360 DAS. The mean value of seven storage stages was also varied significantly among the treatments. Decrease in total soluble oxalate content of corms was found during storage. Oscaran and Savage (2007) [29] reported a similar finding in baked taro leaves and Kumar *et al*. (2017) [30] in elephant foot yam cubes.

Calcium oxalate

Calcium oxalate content of dry and fry cubes prepared from corm also varied significantly among the different treatments (Table-3). At the early stage of storage *i.e.,* at 0 DAS, the cultivar BCA-1 treated with alum @ 1.5 % dry cubes and treated with salt @ 2.0 % fry cubes exhibited significantly higher amount of calcium oxalate (9.39 and 9.12 mg/100g, respectively) fallowed by BCA-1 with salt @ 2.0 % dry cubes, BCA-1with alum @ 1.5 % fry cubes and IGAM-1 with salt @ 1.5 % fry cubes (8.10, 7.78 and 7.34 mg/100g, respectively). Whereas, significantly lowest calcium oxalate content was obtained from IGAM-1 treated with alum @ 2.0 % fry cubes and treated with salt 1.5 % dry cubes with values 6.33 and 7.04 mg/100g, respectively. At 360 days after storage, maximum value (4.59 mg/100g) was recorded in IGAM-1 treated with salt 1.5 % fry cubes which was *at par* with BCA-1 with salt @ 2.0 dry cubes, BCA-1 with alum @ 1.5 % dry cubes, BCA-1 with salt @ 2.0 % fry and IGAM-1 with alum 2.0 % dry (4.55, 4.24, 3.70 and 3.12 mg/100g, respectively). Minimum calcium oxalate content was found in BCA-1 treated with alum @ 1.5 % fry cubes and cultivar IGAM-1 with salt @ 1.5 % dry cubes (0.63 and 0.73 mg/100g). Taking all the storage stage into consideration, it was observed that there was significant variation in mean calcium oxalate content with the value ranging from 0.69 to 9.38 mg/100g, and it also observed that the decrease in calcium oxalate was observed in all cultivar during storage. A similar finding was reported by Parvathi and Subbulakshmi (2016) [31] in elephant foot yam tuber flour and Kumar *et al*. (2013) [32] in elephant foot yam cubes.

Total oxalate

Total oxalate (TO) content of dry and fry cubes corm were significantly influenced by treatments during storage (Table-4). The cultivar BCA-1 treated with salt @ 2.0 % dry cubes and alum 1.5 % dry cubes contained highest amount (31.04 to 30.10 mg/100g, respectively) of TO at 0 DAS, and the same cultivar with same treatment at 360 days of storage recorded the highest amount (18.66 and 17.48 mg/100g, respectively) of TO. While, IGAM-1 treated with alum @ 2.0 % fry cubes and treated salt @ 1.5 % fry cubes contained lowest amount (19.26 to 22.76 mg/100g, respectively) of TO at 0 DAS, and the same cultivar treated with alum @ 2.0 % fry cubes and alum @ 2.0 dry cubes contained lowest amount (10.86 to 12.31 mg/100g, respectively) of TO at 360 DAS. The mean value at seven storage stages was also varied significantly among the cultivars. Decrease in total oxalate content of corms was found during storage. A similar finding was reported by Oscaran and Savage (2007) [29] in baked taro leaves.

Table 1: Changes in Water-soluble oxalate content (mg/100g) in elephant foot yam corm cubes during storage

Cv.\DAS	**0**			**60**			**120**			**180**			**240**			**300**			**360**		
	1st	**2nd**	**Pooled**	**1st**	**2nd**	**Pooled**	**1st**	**2nd**	**Pooled**	**1st**	**2nd**	**Pooled**	**1st**	**2nd**	**Pooled**	**1st**	**2nd**	**Pooled**	**1st**	**2nd**	**Pooled**
BCA-1 Dry (Alum 1.5%)	20.31	21.13	20.72	19.77	20.05	19.91	18.66	18.16	18.41	17.36	17.10	17.23	16.44	16.01	16.23	15.67	14.35	15.01	13.83	12.66	13.25
BCA-1 Dry (Salt 2.0%)	22.84	23.02	22.93	21.09	21.78	21.43	19.98	20.89	20.44	18.58	19.74	19.16	18.04	17.50	17.77	16.87	16.04	16.45	14.34	13.89	14.11
BCA-1 Fry (Alum 1.5%)	17.34	18.23	17.79	16.56	18.01	17.29	15.46	17.12	16.29	14.25	16.54	15.40	14.10	14.73	14.42	13.88	13.26	13.57	12.48	12.30	12.39
BCA-1 Fry (Salt 2.0%)	19.22	20.92	20.07	18.43	20.10	19.27	18.31	18.21	18.26	17.53	18.01	17.77	16.45	17.45	16.95	15.38	15.90	15.64	13.45	13.34	13.39
IGAM-1 Dry (Alum 2.0%)	16.32	15.76	16.04	14.88	14.45	14.66	13.77	12.56	13.17	12.99	11.33	12.16	11.82	11.01	11.42	10.62	9.89	10.26	9.82	8.56	9.19
IGAM-1 Dry (Salt 1.5%)	18.56	19.34	18.95	17.37	18.68	18.03	16.27	16.79	16.53	15.52	16.01	15.77	14.67	15.03	14.85	13.83	13.59	13.71	12.43	11.99	12.21
IGAM-1 Fry (Alum 2.0%)	13.32	12.53	12.93	11.56	11.90	11.73	10.45	11.01	10.73	9.78	10.68	10.23	9.31	9.22	9.27	8.39	9.01	8.70	8.02	8.21	8.12
IGAM-1 Fry (Salt 1.5%)	15.82	15.02	15.42	13.78	14.31	14.05	12.68	12.42	12.55	12.03	11.71	11.87	11.89	10.22	11.06	9.80	9.02	9.41	8.32	7.90	8.11
Mean	17.97	18.25	18.11	16.68	17.41	17.05	15.70	15.89	15.80	14.76	15.14	14.95	14.09	13.90	13.99	13.05	12.63	12.84	11.59	11.11	11.35
	CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed	
C	2.608	1.280	**	2.586	1.269	**	2.176	1.068	**	2.424	1.192	**	2.154	1.057	**	1.788	0.878	**	1.883	0.924	**
Y	1.304	0.640	NS	1.293	0.635	NS	1.088	0.534	NS	1.212	0.595	NS	1.077	0.529	NS	0.894	0.439	NS	0.941	0.462	NS
CY	3.688	1.810	NS	3.657	1.795	NS	3.077	1.510	NS	3.429	1.683	NS	3.046	1.496	NS	2.528	1.241	NS	2.662	1.307	NS

Table 2: Changes in Total soluble oxalate content (mg/100g) in elephant foot yam corm cubes during storage

Cv.\DAS	**0**			**60**			**120**			**180**			**240**			**300**			**360**		
	1st	**2nd**	**Pooled**	**1st**	**2nd**	**Pooled**	**1st**	**2nd**	**Pooled**	**1st**	**2nd**	**Pooled**	**1st**	**2nd**	**Pooled**	**1st**	**2nd**	**Pooled**	**1st**	**2nd**	**Pooled**
BCA-1 Dry (Alum 1.5%)	27.78	26.56	27.17	25.12	25.88	25.50	23.95	24.66	24.31	22.33	21.90	22.12	20.67	19.99	20.33	18.43	17.93	18.18	15.76	16.56	16.16
BCA-1 Dry (Salt 2.0%)	28.99	28.02	28.51	26.63	27.31	26.97	24.69	25.10	24.90	23.78	22.79	23.28	21.34	20.66	21.00	20.20	19.41	19.81	17.90	16.58	17.24
BCA-1 Fry (Alum 1.5%)	23.67	22.60	23.14	21.83	19.56	20.70	17.13	18.47	17.80	16.45	16.91	16.68	15.90	15.62	15.76	14.34	13.90	14.12	12.85	12.79	12.82
BCA-1 Fry (Salt 2.0%)	25.88	26.81	26.35	24.51	25.99	25.25	23.35	22.91	23.13	21.88	22.07	21.98	19.45	20.77	20.11	18.88	17.98	18.43	16.23	15.64	15.94
IGAM-1 Dry (Alum 2.0%)	21.27	20.32	20.80	19.67	18.68	19.17	17.08	16.67	16.87	15.79	14.66	15.23	14.51	13.83	14.17	13.23	12.44	12.83	11.91	10.76	11.33
IGAM-1 Dry (Salt 1.5%)	23.56	24.02	23.79	22.89	21.23	22.06	22.03	19.88	20.96	18.69	17.73	18.21	16.33	15.37	15.85	14.91	14.93	14.92	12.55	12.88	12.71
IGAM-1 Fry (Alum 2.0%)	17.67	16.89	17.28	16.45	15.89	16.17	14.44	14.90	14.67	13.56	12.89	13.22	12.22	11.94	12.08	10.71	11.20	10.96	9.70	10.31	10.01
IGAM-1 Fry (Salt 1.5%)	20.00	20.94	20.47	18.56	18.21	18.39	17.56	16.84	17.20	14.34	15.81	15.07	13.78	14.12	13.95	12.66	12.32	12.49	11.77	10.77	11.27
Mean	23.60	23.27	23.44	21.96	21.59	21.78	20.03	19.93	19.98	18.35	18.09	18.22	16.77	16.54	16.66	15.42	15.01	15.22	13.58	13.29	13.43
	CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed	
C	2.324	1.141	**	2.972	1.459	**	2.697	1.324	**	2.182	1.071	**	2.282	1.120	**	2.342	1.149	**	2.227	1.093	**
Y	1.162	0.570	NS	1.486	0.729	NS	1.348	0.662	NS	1.091	0.535	NS	1.141	0.560	NS	1.171	0.575	NS	1.114	0.546	NS
CY	3.286	1.613	NS	4.203	2.063	NS	3.815	1.873	NS	3.085	1.515	NS	3.227	1.584	NS	3.312	1.626	NS	3.149	1.546	NS

Table 3: Changes in Calcium oxalate content (mg/100g) in elephant foot yam corm cubes during storage

Cv.\DAS	0			60			120			180			240			300			360		
	1st	2nd	Pooled	1st	2nd	Pooled	1st	2nd	Pooled	1st	2nd	Pooled	1st	2nd	Pooled	1st	2nd	Pooled	1st	2nd	Pooled
BCA-1 Dry (Alum 1.5%)	10.86	7.90	9.38	7.78	8.48	8.13	7.69	9.46	8.58	7.23	6.98	7.11	6.15	5.78	5.96	4.03	5.20	4.62	2.80	5.68	4.24
BCA-1 Dry (Salt 2.0%)	8.94	7.27	8.11	8.07	8.05	8.06	6.85	6.13	6.49	7.56	4.44	6.00	4.80	4.59	4.70	4.84	4.91	4.88	5.19	3.91	4.55
BCA-1 Fry (Alum 1.5%)	9.21	6.35	7.78	7.67	2.26	4.96	2.43	1.96	2.20	3.19	0.53	1.86	2.62	1.29	1.95	0.67	0.93	0.80	0.54	0.71	0.63
BCA-1 Fry (Salt 2.0%)	9.68	8.57	9.13	8.84	8.57	8.71	7.33	6.83	7.08	6.34	5.91	6.12	4.36	4.83	4.59	5.08	3.03	4.06	4.04	3.36	3.70
IGAM-1 Dry (Alum 2.0%)	7.19	6.63	6.91	6.98	6.15	6.56	4.81	5.97	5.39	4.07	4.85	4.46	3.91	4.10	4.00	3.80	3.71	3.75	3.03	3.20	3.12
IGAM-1 Dry (Salt 1.5%)	7.27	6.81	7.04	8.03	3.72	5.87	8.39	4.51	6.45	4.61	2.50	3.56	2.42	0.49	1.45	1.57	1.96	1.77	0.17	1.29	0.73
IGAM-1 Fry (Alum 2.0%)	6.32	6.34	6.33	7.12	5.81	6.47	5.80	5.66	5.73	5.50	3.21	4.35	4.23	3.96	4.09	3.38	3.19	3.28	2.44	3.05	2.75
IGAM-1 Fry (Salt 1.5%)	6.08	8.60	7.34	6.95	5.67	6.31	7.11	6.43	6.77	3.35	5.96	4.66	2.74	5.68	4.21	4.16	4.80	4.48	5.01	4.18	4.59
Mean	8.19	7.31	7.75	7.68	6.09	6.88	6.30	5.87	6.09	5.23	4.30	4.76	3.90	3.84	3.87	3.44	3.47	3.45	2.90	3.17	3.04
	CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed	
C	1.096	0.538	**	1.096	0.538	**	1.303	0.639	**	0.844	0.414	**	0.651	0.319	**	0.773	0.379	**	0.473	0.232	**
Y	0.548	0.269	**	0.548	0.269	**	0.652	0.319	NS	0.422	0.207	**	0.325	0.160	NS	0.386	0.189	NS	0.236	0.116	*
CY	1.549	0.761	*	1.549	0.761	**	1.843	0.905	NS	1.194	0.586	**	0.921	0.452	**	1.093	0.537	NS	0.670	0.329	**

Table 4: Changes in Total oxalate content (mg/100g) in elephant foot yam corm cubes during storage

Cv.\DAS	0			60			120			180			240			300			360		
	1st	2nd	Pooled	1st	2nd	Pooled	1st	2nd	Pooled	1st	2nd	Pooled	1st	2nd	Pooled	1st	2nd	Pooled	1st	2nd	Pooled
BCA-1 Dry (Alum 1.5%)	31.17	29.03	30.10	27.55	28.53	28.04	26.35	27.62	26.99	24.59	24.08	24.34	22.59	21.79	22.19	19.69	19.55	19.62	16.63	18.34	17.48
BCA-1 Dry (Salt 2.0%)	31.78	30.30	31.04	29.15	29.83	29.49	26.83	27.02	26.93	26.14	24.17	25.16	22.84	22.09	22.46	21.72	20.94	21.33	19.52	17.80	18.66
BCA-1 Fry (Alum 1.5%)	26.55	24.58	25.57	24.23	20.27	22.25	17.89	19.08	18.49	17.44	17.08	17.26	16.72	16.03	16.37	14.55	14.19	14.37	13.02	13.01	13.02
BCA-1 Fry (Salt 2.0%)	28.90	29.49	29.20	27.27	28.67	27.97	25.64	25.04	25.34	23.86	23.92	23.89	20.81	22.28	21.54	20.46	18.92	19.69	17.49	16.69	17.09
IGAM-1 Dry (Alum 2.0%)	23.52	22.39	22.95	21.85	20.60	21.22	18.58	18.53	18.56	17.06	16.18	16.62	15.73	15.11	15.42	14.42	13.60	14.01	12.85	11.76	12.31
IGAM-1 Dry (Salt 1.5%)	25.83	26.15	25.99	25.40	22.39	23.90	24.65	21.29	22.97	20.13	18.52	19.32	17.09	15.52	16.30	15.40	15.55	15.47	12.60	13.28	12.94
IGAM-1 Fry (Alum 2.0%)	19.64	18.87	19.26	18.68	17.71	18.19	16.25	16.67	16.46	15.28	13.89	14.58	13.54	13.18	13.36	11.76	12.20	11.98	10.46	11.27	10.86
IGAM-1 Fry (Salt 1.5%)	21.90	23.63	22.76	20.73	19.98	20.36	19.79	18.85	19.32	15.39	17.67	16.53	14.64	15.90	15.27	13.96	13.82	13.89	13.33	12.08	12.71
Mean	26.16	25.56	25.86	24.36	23.50	23.93	22.00	21.76	21.88	19.99	19.44	19.71	17.99	17.74	17.86	16.49	16.10	16.30	14.49	14.28	14.38
	CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed		CD 0.05	S Ed	
C	2.882	1.415	**	2.430	1.193	**	2.548	1.251	**	2.696	1.323	**	2.338	1.147	**	2.752	1.351	**	2.175	1.068	**
Y	1.441	0.707	NS	1.215	0.596	NS	1.274	0.625	NS	1.348	0.662	NS	1.169	0.574	NS	1.376	0.675	NS	1.088	0.534	NS
CY	4.076	2.001	NS	3.437	1.687	NS	3.604	1.769	NS	3.812	1.871	NS	3.306	1.623	NS	3.891	1.910	NS	3.076	1.510	NS

C\Cv- Cultivar, Y-Year, CD- Critical Difference at 5%, S Ed- Standard Error of Deviation, DAS- Days After Storage, R- Replication (3)

Conclusion

The present study indicates that the oxalate content was significantly different during storage. This paper demonstrates the level of oxalate content at various stages during storage of elephant foot yam dry and fry cubes which was very low oxalate, should not be ignored because these are under permissible limit and even these may be used as vegetables during the scarcity of vegetables in the market because these underutilized vegetable can't be stored for longer duration after harvest. The cv. IGAM-1 treated with alum 2 % was found best for making dry and fry cubes because it content least amount of oxalate. We hope that this study will help to propagate knowledge on these underutilized vegetable for their commercial cultivation and it provide breeders and researchers with the ability to develop desirable types having high yield and better antinutritional profile cultivar of elephant foot yam.

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