International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 23, 2018, pp.-7595-7598.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

CALCIUM-OXALATE AND DIVERSITY IN EDIBLE *Alocasia* Spp.

B.R. JANA*
ICAR-RCER, Research Centre for Makhana, Darbhanga, 846005, Bihar, India
*Corresponding Author: Email- brjana.ars@gmail.com

Received: November 01, 2018; Revised: December 11, 2018; Accepted: December 12, 2018; Published: December 15, 2018

Abstract: In India, three types of *Alocasia* viz., *Alocasia cuculata* (Lour.) *Alocasia indica* (Schott) and *Alocasia macrorrhizos* (L.) Schott. were available specially in Bengal, Assam and South India in abundance. In ICAR-RCER, Research Centre for Makhana, 10 edible *Alocasia* accessions from Bengal, Jharkhand and Bihar were collected and evaluated during 2015-16 on the basis of morphological characters, yield and Ca-oxalate content. Results revealed that Ranchi-3 collection, *Alocasia indica* was dwarf whose horizontal root along with stem were edible (2.24 kg/plant/season). West Bengal-1 (WB-1) was suitable for post-harvest product making like Bari. RKM collections (*Alocasia macrorrhizos*) were large and edible like RKM-2 having 1122 sq cm leaf area where as RKM-3 produced the highest rhizome yield of 2.9 kg/plant/year. Morphological variations were found in rhizome length, weight of tuber and number of flowers significantly. To minimize raphides content, the rhizome was planted in different growth media *viz*., T1=Wet soil, T2=Fertile soil, T3=Fertile soil (50%) + leaf mould (50%) and T4= Fertile soil (50%) + leaf mould (25%) + ash (25%). Rhizomes of RKM-3 were also treated with different $NaHCO_3$ concentrations *viz*; 1.0%, 1.5% 2.0%, 2.5% and 3%. It was noticed that T4 produced healthy and bigger plant with minimum calcium oxalate content of 72.66 mg/100 g edible. Ranchi -3 had very low in Ca-oxalate (13.46 mg/100g edible) which was further decimated during thermal preparation. In case of RKM -3 after treating with 2% (w/v) sodium bi carbonate for 20 minutes resulted in lower Ca-oxalate content of 71.47 mg/100 g edible.

Keywords: *Alocasia*, Vegetables, Arthritis, Promising food

Citation: B.R. Jana (2018) Calcium-Oxalate and Diversity in Edible *Alocasia* Spp. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 23, pp.- 7595-7598.

Introduction

Alocasia is a minor vegetable crop grown in India where tropical rain forest or tropical humid climate present and used generally by rural poor and tribes. In India three kinds of *Alocasia* are mainly grown in Assam, West Bengal Maharashtra, Odisha and Bihar. The substantial amounts of *Alocasia* are consumed at North Eastern States and West Bengal. Three species of *Alocasia* are *indica*, *macrorrhizos* and *cuculata*. *Alocasia macrorrhizos*, is a very tall plant, present scatteredly in some parts of India particularly in neglected and degraded soil with polluted water. The decapitated *Alocasia* rhizome and fleshy stem are used for vegetable after prolong cooking. The post-harvest product like making bari and rhizome powder are used against arthritis and kidney stone. The most of the *Alocasia* spp. contain raphides. Giant taro [*Alocasia macrorrhizos* L. Schott] is a member of family Araceae and is a native of the tropical region between India and Indonesia and Asia-Pacific regions that are considered to be the primary centre of origin [1]. Giant taro plant produces edible corm [2], which is very rich in carbohydrates, ranging between 73 to 80% in form of starch and 1.4% crude fibre. Giant taro is also a good source of dietary protein, thiamine, riboflavin, iron, phosphorus and zinc and a very good source of vitamin B6, vitamin C, niacin, potassium, copper and manganese [3]. In addition, corms of taro family are especially useful to persons allergic to cereals and children who are sensitive to milk [4]. The nutritional value of food depends largely upon their nutritional contents, digestibility and the presence or absence of anti-nutrients and toxic factors [5]. Most taro cultivars taste acrid. This acridity is caused by an anti-nutrient namely calcium oxalate presents as fine needle-like crystals or raphides, [6]. Thereafter an irritant present on the raphides, probably a protease can cause discomfort in the tissue [7]. Permissible limit of raphides or Ca-oxalate in *Alocasia* food is 71.0 mg/100 g edible [8]. Consumption of food containing excessive raphides resulted in outbreak of food borne illness [9]. The reduction in calcium oxalate content may be done in raw giant taro through washing, peeling, dicing, soaking overnight, blanching and drying [5,10]. Therefore, present study was undertaken to evaluate suitable types of *Alocasia* fit for human consumption with special reference to Ca-oxalate content and to bring it in cropping system mode with makhana /gorgon nut and wetland medicinal crop like sweet flag at Research Centre Makhana under ICAR-RCER.

Materials and Methods

Ten *Alocasia* germplasm were collected from three states of eastern India like West Bengal, Jharkhand and Bihar. Germplasm were procured in form of tuber and rhizome. Ten types of rhizomes were collected during the March 2015 and planted at bundh at an interval of 1 m X 1 m distance. Monthly data were taken from experimental plots designed with randomized block design (RBD) with three replications. Data were analyzed by taking ANOVA (RBD) of each germplasm explained as treatment. The experiment was conducted at Research Centre on Makhana, Darbhanga under ICAR-RCER during 2015-16. Soil is little bit basic, pH> 7.2. Soil were sandy loam with low water table which was suitable for *Alocasia* or *Colocasia* cultivation. Two kg vermicompost and 250 gm DAP/ plant were given during initial stage of plant establishment. Data were taken after 90-120 days of plantation. Plant height, leaf area and tuber yield data were taken by standard methods. For soil trial to minimize raphides content, the rhizome was planted in different growth media *viz*., T1=Wet soil with tank and silt, T2=Fertile soil (soil of RCM, Darbhanga =basic soil), T3=Fertile soil (50%) + leaf mould (50%) and T4= Fertile soil (50%) + leaf mould (25%) +ash (25%). Planting material was RKM-3 (*Alocasia macrorrhizos*). After harvesting, rhizomes were cut into pieces treated with different $NaHCO_3$ concentrations like. 1.0%, 1.5% 2.0%, 2.5% and 3.0% solution for 20 minutes. After that samples were washed and dried. Calcium-oxalate was determined according to [11]. Digestion, oxalate precipitation and permanganate titration were three major steps.

Table-1 *Characteristics of Alocasia plants collected from different parts of eastern India during 2015-16*

Alocasia Selections	*Alocasia spp.*	Leaf Shape	Leaf Character	Calcium Oxalate Content of Tuber (mg/100.0g)
Ranchi-1 Jharkhand	*Alocasia macrorrhizos*	Oblong	Large leaf Sagittarius	89.02
Ranchi-2 Jharkhand	*Alocasia indica*	Elongated	Large leathery leaf , Sagittarius	108.78
Ranchi-3 Jharkhand	*Alocasia indica*	Oblong	Small leaf Sagittarius like Colocasia	13.46
Darbhanga-1 Bihar	*Alocasia macrorrhizos*	Elongated	Large leaf Sagittarius	92.25
Darbhanga-2 Bihar	*Alocasia macrorrhizos*	Elongated	Large leaf Sagitarious	94.36
RKM -1 Kolkata	*Alocasia macrorrhizos*	Broadly Ovate	Spreading Medium leaf, Sagitarious	83.22
RKM -2 Kolkata	*Alocasia macrorrhizos*	Broadly Ovate	Spreading, Medium leaf Sagitarious	88.62
RKM -3 Kolkata	*Alocasia macrorrhizos*	Broadly Ovate	Large leaf, Sagitarious	83.75
W.B.-1 East Midnapur	*Alocasia macrorrhizos*	Nearly Round	Small leaf, Ovate	72.04
W.B. 2 East Midnapur	*Alocasia cuculata*	Ovate	Spreading, Medium leaf Sagitarious	77.49

**Permissible limit of Ca-oxalate in Food=71.0 mg/100g edible [8]*

Table-2 *Growth parameters of Alocasia germplasm at RCM, Darbhanga during 2015-16*

Alocasia Selections	Height of Plants(cm)	Number of Eyes/tuber	Leaf Area(cm^2)	Tuber Yield/plant(g)
Ranchi-1	40.0	3.0	630.00	900.00
Ranchi-2	41.0	3.0	375.00	900.00
Ranchi-3	50.0	8.0	280.00	2240.00
Darbhanga-1	58.0	3.0	44.00	1200.00
Darbhanga-2	61.0	3.0	559.00	1350.00
RKM Collection-1	58.0	1.0	840.00	750.00
RKM Collection-2	49.0	1.0	961.00	850.00
RKM Collection-3	60.0	1.0	1122.00	2900.00
W.B.-1 East Midnapur	30.0	1.0	120.00	280.00
W.B. 2 East Midnapur	45.0	2.0	792.00	2060.00
CD at 5%	2.34	0.42	108.90	28.85

Reduction in raphides by using sodium bi-carbonate was also performed according to [12]. Population variance was measured from average squared deviation from the mean.

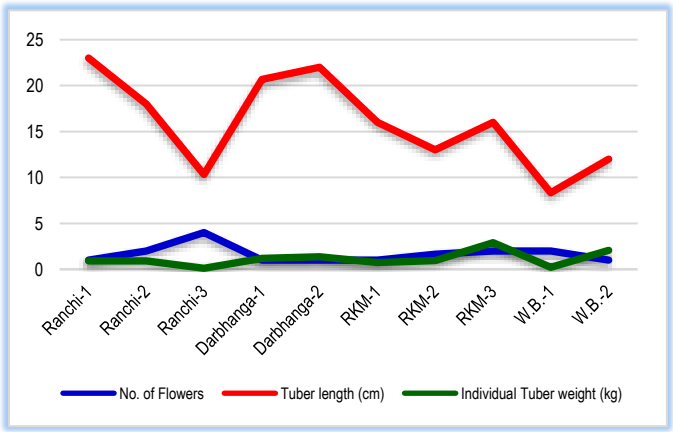
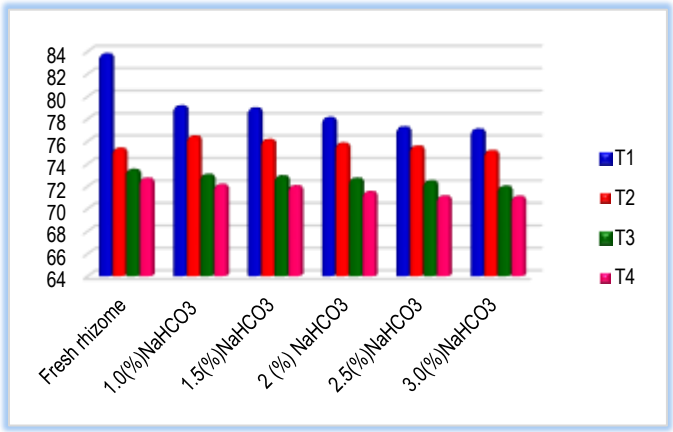


Fig-1 Morphological variation in important traits like inflorescence number (0.88*), tuber length (25.31*) and tuber weight (0.70*)



T_1=Wet soil (silt from waste water), T_2= Fertile soil (soil pH >7.2), T_3=Fertile soil (50%)+leaf mould(50%). And T_4= Fertile soil (50 %) + leaf mould (25%) +ash (25%)

Fig-2 Variation in (Ca-oxalate) content as affected by growing media and different $NaHCO_3$

Results and Discussion

Morphological variation and yield

Ten promising *Alocasia* germplasm were maintained and evaluated in ICAR-RCER, Research Centre on Makhana, as a minor vegetable for the poor and needy people of Mithilanchal, Bihar. There were morphological differences in height of plant and tuber weight *i.e.* yields. Among 10 germplasm Ranchi-3 was the best and it was *Alocasia indica*, growing up to 50-60 cm height and its rhizome and horizontal expansion of root tuber were both edible and also kept for multiplication. It's production was 2.24 kg/plant/year. This result was corroborated with the work of [13]. It was planted at 2nd week of March and it was fit for consumption after one season of cultivation. Ram Krishna Mission Collection-3, namely RKM-3 was *macrorrhizos* and had vigorous growth with upright leaves. According to [14] *Alocasia* Tonga' with an average stem weight of 38.9 pounds and' accession 18' with an average weight of 35.6 pounds were observed at Hawaii. A close perusal of the [Table-2] revealed that dwarf germplasm was West Bengal-1 which was collected from East Midnapur and was soft type suitable for processing purposes. The maximum number of eyes in the planting material was 8 in case of germplasm Ranchi-3. The maximum leaf area was found in R.K.M. Collection -2 having 1122 sq cm. In Ranchi collection leaf shape was like oblong but the leaves of Darbhanga, Bihar collection was elongated. Unlike Darbhanga Collection leaves of the RKM collections were obovate and the leaves of the germplasm of W.B.-1 are almost ovate as it was too small. Inflorescence number per plant, length of tuber and tuber weight indicated population variance of 0.88, 25.31 and 0.70 respectively and in our case the highest inflorescence number was observed in Ranchi-3 (4.00). This result was also supported by [13, 15]. From the experiment it had been found that *Alocasia* could be grown at top level with makhana and sweet flag. All *Alocasia* germplasm from Darbhanga were quick growing and edible due to adaptation in local climate, which was also described by [16]. *Alocasia macrorrhizos* was perennial plant and showed more growth and yield in long term.

Growing media and Ca-oxalate

A close perusal of the [Table-1] revealed that Ranchi-3 cultivar possessed the low amount of Ca-oxalate (13.46 mg /100 g edible). RKM -3 produced very attractive large rhizome, which had Ca-oxalate concentration of 83.75 mg/100g. It has been found that from [Fig-2], T4 [T4= fertile soil (50 %) + leaf mould (25%) + ash (25%)] reduced Ca-oxalate content to72.66 mg/100 g but T1 was acrid (83.75 mg/100 g).

Plate-1 Ranchi-3(Flowers: 4.0 in a caladium)

Plate-2 RKM--3 (Flowers: 2.0 in a caladium)

Plate-3 Fox nut + Sweet flag +*Alocasia*

Plate-4 2% $NaHCO_3$ treated *Alocasia macrorrhizos*

The rhizome of RKM-3 was treated with 2.0 percent $NaHCO_3$ for 20 minutes resulted in further reduction of Ca-oxalate and the food was more acceptable (71.47mg/100 g). According to [17] appropriate cooking resulted in reduction of raphides content in *Alocasia* rhizome.

Conclusion

From the present study, it can be concluded that *A. indica* collection Ranchi-3 was purely vegetable crop and suitable for cultivation under eastern India. *Alocasia macrorrhizos* collection RKM-3 can be used after treating with 2 % $NaHCO_3$ and subsequent boiling. Though *Alocasia* was a self-pollinated and homozygous plant yet considerable significant variations were also observed in tuber length, weight and number flowers in a caladium.

Application of research: Development of procedure for reduction of Ca-oxalate content in *Alocasia* spp to become more edible and sorting out the cultivable plant and selections to recognize as edible food.

Research Category: Crop Production and Improvement.

Abbreviations:

Sodium-bi-carbonate = $NaHCO_3$
Randomized Block Design = RBD
Analysis of Variance = ANOVA, Di-Ammonium Phosphate = DAP
Ram Krishna Mission = RKM, Research Centre for Makhana = RCM

Acknowledgement / Funding: Author is thankful to ICAR-RCER, Research Centre for Makhana, Darbhanga, 846005, Bihar, India

***Principal Investigator or Chairperson of research: Dr B.R. Jana**
Institute: ICAR-RCER, Research Centre for Makhana, Darbhanga, 846005, Bihar
Research project name or number: Research station trials

Author Contributions: Sole author

Author statement: Author read, reviewed, agreed and approved the final manuscript. Note-Author agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

References

[1] Matthews P. (2004) *Ethnobotany Journal*, 2 (1547), 55-77.
[2] Chay-Prove P. and Goebel R. (2004) *Taro, the plant. Queensland, Department of Primary Industries and Fisheries-Queensland Government Australia.*
[3] Soudy I.D., Delatour P. and Grancher D. (2010) *Revere De Medecime Vetterinarire*, 1,37-42.

[4] Huang C.C., Chen W.C. and Wang C.C.R. (2007) *Food Chemistry*, 102, 250-256.
[5] Alcantara R.M., Hurtada W.A. and Dizon E.I. (2013) *Journal of Nutrition and Food Sciences*, 3 (3),207-209.
[6] Bradbury J.H. and Nixon R. (1998) *Journal of Science, Food and Agriculture*, 76, 608-616.
[7] Paull R., Tang C., Gross K. and Uruu G. (1999) *Postharvest Biology Technology*, 16, 71-78.
[8] Kumoro A.C., Budiyati C.S. and Retnowati D.S. (2014) *International Food Research Journal* 21(4), 1583-1588.
[9] Watson John T., Jones Roderick C., Siston Alicia M., Diaz, Pamela S., Gerber Susan I., Crowe John B., Satzger R. Duane (2005) *Clinical Toxicology*, 43 (1), 17-21.
[10] Shanthakumari S., Mohan V. and De Britto J. (2008) *Tropical and Subtropical Agro-ecosystems* 8, 313-319.
[11] AOAC. (1990) *Official Methods of Analysis. 15th edn. Washington D.C., Association of Official Analytical Chemists.*
[12] Ranganna S. (1996) *Handbook of analysis and quality control of fruit and vegetable products. Tata McGraw Hill Publishing Company New Delhi.*
[13] Garcia J.Q., Evancic A. and Lebot V. (2008) *New Zealand J. Bot.*, 46(2), 109-203
[14] Sione Foliaki, William S. Sakai, Sauni T. Tongatule, Unlucky Tungata (1980) *Potential for production of Alocasia, giant taro on the Hemacua Coast of the Island of Hawaii. Research Extension series I Hawaii Institute of Tropical Agriculture and Human Resource, USA.*
[15] Evancic A. and Lebot V. (2000) *The genetics and breeding of taro. Montpellier, France Sereies Reperes, CIRAD.*
[16] Plucknett D.L. (1984) *Edible Aroids, In Simonds's NW ed. Evaluation of crop plants, London and New York, Longman,* pp10-12.
[17] Iwuoha C.I. and Kalu F. A. (1995) *Food Chemistry* 54, 61-66.