OPEN ACCESS Freely available online

Journal of Nutrition & Food Sciences

ISSN: 2155-9600

Review Article

Oxalate and Mineral Composition of Amoche (*Arisaema schimperianum S)* as Influenced by Different Processing

Halabo Hazo[1*], Ghulam Hassan Shah[1], Mary Murimi[2]

[1]*Department of Food Science and Postharvest Technology, Arba Minch University, Arba Minch, Ethiopia;* [2]*Department of Human Nutrition, Texas Technical University, Texas, USA*

ABSTRACT

Amoche *(Arisaema schimperianum Schott)* is herbaceous tuber crop that belongs to the family Araceae and sub family Aroideae. They provide important plant foods for many indigenous people of the tropics and subtropics. However, some -members of this family are poisonous containing alkaloids and other toxins. High content of oxalate in foods, which bind the essential minerals like calcium, magnesium, iron and zinc. It also forms needle like raphides of calcium oxalate crystals, that responds the food to acridity, irritation, inflammation and burning sensation followed by swelling of hands, mouth, lips and throat irritation as major causes for the health related problems. Oxalate content of amoche as influenced by different processing were determined by High Performance Liquid Chromatography. The mineral contents were also determined by Atomic Absorpition Spectrophotometre. The different processing treatments were combinations of three levels of fresh, boiliing, drying and three levels of soaking in ginger juice, lemon juice and ethanol and neither heating nor boiling (control). Different processing treatment were significantly ($p<0.05$) influenced the oxalate and mineral contents of amoche. The oxalate contents in fresh amoche was observed as major hindrance for safe consumption. Generally there was a reduction of oxalate from 970.92-268 mg/100 g for boiled amoche after soaked in lemon juice, which showed 72.39% reduction. However, there was slight reduction of minerals content in all treatments than control. Boiling amoche after soaking in low pH can reduce the level of oxalate content. Amoche daily consumption level should not exceed (50 to 100 mg/100 g/ 2500 Kcal/day). Considering these consumption can be worked out 268 mg/100 g of boiled *amoche* after soaked in lemon juice.

Keywords: Amoche; Heating; Soaking; Oxalate; Minerals

INTRODUCTION

Amoche (*Arisaema schimperianum Schott.)* is herbaceous tuber crop that belongs to the family Araceae and sub family Aroideae. Though 105 genera and over 2000 species of the family are found in all climatic regions of the world, but they mainly grow in tropical or subtropical regions. There are several edible tubers or stems of this family such as taro *(Colocasia),* giant taro *(Alocasia),* tania or yautia *(Xanthosoma),* elephant foot yam *(Amorphophallus),* swamp taro *(Cyrtosperma)* amoche *(Arisaema).* Aroids are tuber or underground stem bearing plants belonging to the family Araceae. It is well adapted to wet climates and can give good yields in waterlogged or swampy soils. They provide important plant foods for many indigenous people of the tropics and subtropics. However, some members of this family are poisonous containing alkaloids and other toxins [1].

Distribution of amoche is found in the Himalayas from Eastern Afghanistan to Bhutan, in South-eastern Tibet and Western China (Sichuan, Yunnan); 1800 to 4500 meter above sea level. In addition, the species also found in Southern Arabia (Oman, Yemen and Saudi Arabia) and even in North Eastern Africa (Ethiopia). The genera growing naturally in Ethiopia are members of three different subfamilies: Lasioideae, Aroideae

Corresponding author: Halabo Hazo, Department of Food Science and Postharvest Technology, Arba Minch University, Arba Minch, Ethiopia; Tel: 251920978841; E-mail: halaboazo@gmail.com

Received date: May 03, 2021; **Accepted date:** May 17, 2021; **Published date**: May 24, 2021

Citation: Hazo H, Shah GH, Murimi M (2021) Oxalate and Mineral Composition of Amoche *(Arisaema schimperianum S.)* as Influenced by Different Processing. J Nutr Food Sci. 11:807.

and Pistoideae. The taxa indigenous to Ethiopia are found in seven genera with 15 species; there are four or more cultivated and/or ornamental taxa [2].

Earlier researchers identified 12 to 15 types of amoche in the Southern Ethiopia. There are morphologically distinct types of amoche in the Gamo Zone type. This types differ with respect to morphological characters such as leaflet number and color, stem color, plant height, flower color, maturity period, vigor and relative level of irritability to the skin and mouth. Amoche is cultivated mainly for its tuber like yam, cocoyam, elephant foot yam and taro. It is used as source of food and as a planting material [3].

Dita area of Gamo Zone is a hilly area which is generally affected by drought conditions. In such area of insufficient food production the situation becomes more adverse as and when there is drought. Thus the local population has no available food source. Under such condition Amoche tubers are generally consider as major alternate food source for the local population. A large area in Ethiopia falls under rough and inaccessible terrain like Dita. The cultivated crops in these areas provide food to population for a short period of the year, but in most of the months there is acute food shortage. For their survival the local population has explored the use of wild tuber crop amoche, growing in these areas. However, despite the fact that the amoche tuber satisfies hunger, most people experience some discomforts after consumption such as lips and throat irritation, kidney failure, stomach disturbance, night blindness, edema and other health problems. Health problems caused after consuming amoche is considered to be of the same nature. Earlier researchers reported the presence of high content of oxalate in foods, which bind the essential minerals like calcium, magnesium, iron and zinc. It also forms needle like raphides of calcium oxalate crystals, that responds the food to acridity, irritation, inflammation and burning sensation followed by swelling of hands, mouth, lips and throat irritation as major causes for the health related problems. Therefore, this study was initiated to observe the effect of different processing on oxalate and mineral composition of amoche [4].

MATERIALS AND METHODS

Sample collection

Amoche tubers were collected from Dita Woreda Gamo sub-administrative zone. This area is known in Ethiopia for production and consumption of amoche for food purpose in case of off season. With objective to give a proper coverage to the area two similar sites, were selected in the area for collection of amoche tubers. Amoche samples comprised of different sized tubers (large, medium and small) and free from mechanical and pest damage. Samples were directly purchased from randomly selected farmers, they were packed in polyethylene plastic bags after ensuring uniformity, labelled and transported to Department of Food Science and Postharvest technology, Arba Minch University [5].

Lemon fruit having the uniform size, shape, colour and free from any mechanical and pest damage was purchased from sickle local market, Arba Minch town. Lemon juice extraction was completed by manually after cutting the fruit in two parts and the juice extract was collected in plastic jock. Ginger root which have the same freshness, mechanical and pest damage free was purchased from sickle local market, Arba Minch town. Extraction was completed by using juice maker after finely slicing with steeliness steel knife and the juice extract was collected in plastic jock. Ethanol was purchased from local alcohol and processing house of Arba Minch town.

Sample preparation

Amoche samples were gently washed and peeled carefully using stainless steel knives. The peeled amoche samples were washed, rinsed with deionized water and then sliced to a uniform size of three centimeter, and distributed in different four lots. Each of the lots was sub divided in to three sub lots. Three sub lots were separately soaked in 1:2 ratio of amoche slice in kilogram to solutions in liter for two days at room temperature in the solutions of ethanol, ginger juice and lemon juice having its pH value of 5.12, 3.59 and 2.01 respectively. Three sub lots were not soaked in any solution. Each solutions was drained off after soaking process completed. For each of treatment one out of the three lots was subsequently boiled in water, one was dried in oven and one was neither boiled nor dried [6].

After soaking the amoche slices in three different solvents, one sub lot from each solvent was used for boiling at 100°C in potable water for 20 minutes using an electrical heating of (model GMP MSI 83, China). The boiling water was discarded after boiling process completed. The second sub-lot of each treatment was dried in oven dry (model GX 3020, GAOXIO, Co, Ltd, China) at 70 for 15 hours. The third sub lot was neither dried nor boiled which is referring to the farmers practice (control).

Oxalate determination

Total oxalate contents of amoche samples were determined using the method developed by, while soluble oxalate contents of the amoche samples were determined following the method outlined by using high performance liquid chromatography and insoluble oxalate content was calculated by the difference between the total oxalate and soluble oxalate contents [7].

RESULTS

Standard AOAC method was used to determine minerals (Ca, Mg, Zn and Fe) using standard analytical methods using spectrophotometer (Model AAS 3, Carl Zeiss, Germany). The collected data was subjected to analysis of variance (ANOVA) by using SAS software version 9.0 and mean separation was done using Duncan's multiple range tests at 5% level of significance (Tables 1-2).

Table 1: Interaction effect of heating and soaking on oxalate of Amoche (mg/100 g).

Treatments	Total oxalate	Soluble oxalate	Insoluble oxalate
Control	970.92ᵃ	539.69ᵃ	431.24ᵃ
Fresh Amoche +ginger	848.68ᵇ	518.73ᵇᵃ	329.98ᵈ
Fresh Amoche +lemon	611.15ᶠ	339.61ᵉ	271.53ʰ
Fresh Amoche +ethanol	749.55ᵈ	476.81ᵈᶜ	372.74ʰᵍ
Boiled Amoche	547.33ᵍ	328.33ᵉ	219ⁱ
Boiled Amoche +ginger	546.67ᵍ	266.33ᶠ	280.33ᵍ
Boiled Amoche +lemon	268ʰ	154.67ᵍ	112.67ʲ
Boiled Amoche +ethanol	763 ᵈᶜ	445.66ᵈ	317.667ᵉᶠ
Dried Amoche	842.67ᵇ	519 ᵇᵃ	322.67ᵉᵈ
Dried Amoche +ginger	764.33ᵈᶜ	467.33ᵈᶜ	397ᵇ
Dried Amoche +lemon	657 ᵉ	317.67ᵉ	339.33ᶜ
Dried Amoche +ethanol	798.33ᶜ	485.67ᵇᶜ	312.33ᶠ
CV%	3.3	5.18	1.66
LSD	38.7	35.3	8.4

Means followed by the same letter (s) within a column are not significantly different at p<0.05% CV: Coefficient of Variation LSD: Least Significant Difference.

Table 2: Interaction effect of heating and soaking on calcium, magnesium, zinc and iron content of Amoche (mg/100 g).

Treatments	Ca	Mg	Zn	Fe
Control	17.83 ᵃ	22.72ᵃ	8.71ᵃ	8.95ᵃ
Fresh amoche +ginger	13.29 ᵉ	18.69ᵈᶜ	6.32ᵉ	6.58ᵉᵈ
Fresh amoche +lemon	11.54ᶠ	15.55ᵉ	6.71ᵈ	5.77ᶠᵍ
Fresh amoche +ethanol	15.60ᶜ	20.89ᵇ	7.42ᶜᵇ	7.31ᵇᶜ
Boiled amoche	9.55ʰ	18.12ᵈ	6.47ᵉᵈ	6.26ᶠᵉ
Boiled amoche +ginger	7.39 ʲ	16.24ᵉ	5.5 ᶠ	5.5ᵍ
Boiled amoche +lemon	6.38ᵏ	10.74ᶠ	3.44ᵍ	3.70ʰ
Boiled amoche +ethanol	8.42ⁱ	15.71ᵉ	6.30ᵉ	6.8ᶜᵉᵈ
Dried amoche	16.23ᵇ	21.29ᵇ	7.36ᶜᵇ	7.01ᶜᵇᵈ
Dried amoche +ginger	14.26ᵈ	19.51ᶜ	7.22ᶜ	7.17ᶜᵇᵈ
Dried amoche +emon	10.17ᵍ	17.93ᵈ	6.43ᵉᵈ	6.78ᶜᵉᵈ
Dried amoche +ethanol	15.38ᶜ	20.70ᵇ	7.67ᵇ	7.56 ᵇ
CV%	2.98	3.83	3.3	5.63
LSD	0.6	1.1	0.3	0.6

Means followed by the same letter (s) within a column are not significantly different at p<0.05%; Ca: Calcium, Mg: Magnesium, Zn: Zinc, Fe: Iron, CV: Coefficient of Variation and LSD: Least Significant Difference.

DISCUSSION

Oxalate content

Total oxalate, soluble oxalate and insoluble oxalate content of the raw and processed amoche are presented in Table 1. The heating and soaking interaction significantly (P<0.05) affected the total oxalate, soluble oxalate and insoluble oxalate concentration. On wet basis 970.92 mg/100 g total oxalate, 539.69 mg/100 g soluble oxalate and 431.24 mg/100 g were recorded in control, whereas in processed amoche these values ranged from 268 mg/100 g to 848.68 mg/100 g for total oxalate 154.67 mg/100 g to 518.73 mg/100 g for soluble oxalate and 112.67 mg/100 g to 329.98 mg/100 g for insoluble oxalate. The oxalate content in fresh amoche obtained varied greatly from processed. These result show that amoche tuber has high total oxalate content than that reported by 278 to 574 mg/100 g and 486 to 786 mg/100 g of total oxalate in fresh taro and yam respectively.

From all treatments boiled amoche treated with lemon juices had the lowest content of 268 mg/100 g, 154.67 mg/100 g and 112.67 mg/100 g of total, soluble and insoluble oxalate respectively. This could be due to fact that boiling damages the cell wall of amoche and soaking in lemon juice which have low pH value of (2.01) converts the free oxalate ion to semi-dehydro oxalic acid and oxalic acid, thus solubilized and dissolved oxalate is leaching and drained off with lemon juice and boiling water.

Amoche treated with ginger juice recorded the highest content of total oxalate (848.68 mg/100 g) and soluble oxalate (539.69 mg/100 g), but 397 mg/100 g of insoluble oxalates were recorded in dried amoche treated with ginger juice. The soluble to total oxalate ratio was found to be 55.58% in fresh amoche whereas, in processed amoche this value ranged from 48.34% to 63.61%. The highest total oxalate to soluble oxalate 63.61% was recorded in amoche treated with ethanol, whereas the lowest percentage (48.34%) was observed in dried amoche treated with ethanol followed by 48.51% in boiled amoche treated with lemon juice.

In all treatments the value of total oxalate and soluble oxalate content is reducing control. The maximum reduction percentage of 72.39% of total oxalate and 71.34% soluble oxalate was observed in boiled amoche treated with lemon juice, whereas the minimum reduction percentage of 12.59% total oxalate and 3.88% soluble oxalate were observed in treated amoche with ginger juice. More oxalate loss is not expected if samples are dried and the boiling water is not drained off. The reduction percentage range of total oxalate from 12.59 to 72.39% was similar to the results of reported 20% to 72% reduction of total oxalate in taro sample and 50%-73% in yam samples. That could be due to the fact that boiling damages the cell wall and oxalate leached and drained off with the boiling water.

The higher percentage of oxalate reduction during soaking with lemon juice may also be due to bioavailability of the free oxalate ion in amoche and its solubility in low pH value. Boiling may cause considerable skin rupture and facilitate the leakage of soluble oxalate into cooking water. This may be the possible reason for the observed high reduction in oxalate level upon boiling [4]. The reduced oxalate content on cooked tubers could have positive impact on the health of consumers. The reduction of oxalate levels on soaking is expected to enhance the bioavailability of essential dietary minerals of tubers and reduce the risk of kidney stones occurring among consumers [7].

Mineral composition

Minerals composition content of the raw and processed amoche are presented in Table 2. The interaction of heating and soaking had significantly ($p<0.05$) affected the calcium content of amoche. Calcium content of 17.83 mg/100 g on fresh weight was recorded in unprocessed amoche /control, whereas it ranged from 6.38 mg/100 g to 16.23 mg/100 g in processed amoche. The highest calcium content of 17.83 mg/100 g, 16.23 mg/100 g, 15.60 mg/100 g and 15.35 mg/100 g were observed in fresh amoche, oven dried, amoche treated with ethanol and dried amoche treated with ethanol respectively. The lowest calcium content of 6.38 mg/100 g was observed in boiled amoche treated with lemon juice followed by boiled amoche treated with ginger juice 7.39 mg/100 g. The highest loss of calcium 64.21% and 58.55% were observed in boiled amoche treated with lemon juice and boiled amoche treated with ginger juice respectively, whereas the lowest loss percentage of calcium 8.4% and 11.9% were observed in dried amoche not soaked and ethanol treated amoche respectively. This could be due to high leaching of the calcium with the heating (boiling water) that contributes for the decrement of the calcium content. Overall calcium content was lower in low pH value.

The heating and soaking interaction had significantly ($p<0.05$) affected the magnesium content of amoche. Magnesium content of 22.72 mg/100 g on fresh weight was recorded in control, whereas it ranged from 10.74 mg/100 g to 21.29 mg/100 g in processed amoche. The highest magnesium content of 22.72 mg/100 g, 21.29 mg/100 g, 20.89mg/100 g and 20.70 mg/100 g were observed in control, dried amoche, amoche treated with ethanol and dried amoche treated with ethanol respectively, whereas the lowest magnesium content of 10.74 mg/100 g was observed in boiled amoche treated with lemon juice followed by amoche treated with lemon juice 15.55 mg/100 g. This might be due to the fact that magnesium in oxalate has less solubility .

The heating and soaking interaction had significantly ($p<0.05$) affected the zinc content of amoche. Zinc content of 8.71 mg/100 g on fresh weight was recorded in fresh amoche, but in case of processed amoche it ranged from 3.44 mg/100 g to 7.67 mg/100 g. The highest zinc content of 8.71 mg/100 g and 7.67 mg/100 g were observed in fresh amoche and dried amoche treated with ethanol respectively. Lowest zinc content of 3.44 mg/100 g was observed in boiled amoche treated with lemon juice followed by amoche treated with ginger juice 5.5 mg/100 g. This could be due to that the zinc is leaching off with boiling water and high soluble in low pH.

Amoche can be a better option for supplementing zinc requirements than other root and tuber crops like yam. As is observed in the present finding amoche has zinc content of ranging between 3.44 mg/100 g and 8.71 mg/100 g, The highest percentage loss of zinc 60.5% and 36.85% was observed in boiled amoche treated with lemon juice and boiled amoche treated with ginger juice respectively, whereas the lowest percentage loss 11.94% were observed in dried amoche treated with ethanol.

The interaction of heating and soaking had significantly ($p<0.05$) affected the iron content of amoche. The iron content of 8.95 mg/100 g was recorded in control treatment, whereas it ranged from 3.70 mg/100 g to 7.56 mg/100 g in processed amoche. The highest iron content of 8.95 mg/100 g and 7.56 mg/100 g were observed in control and dried amoche treated with ethanol respectively. Lowest iron content of 3.70 mg/100 g was observed in boiled amoche treated with lemon juice followed by amoche treated with ginger juice 5.5 mg/100 g. This could be due to iron present in form of insoluble complexes (Fe^{3+}) with oxalate. The highest percentage loss of iron 58.65% and 38.54% was observed in boiled amoche treated with lemon juice and boiled amoche treated with ginger juice respectively, whereas the lowest percentage loss 15.53% was observed in dried amoche treated with ethanol. The iron content shows decline after processing of amoche. The percentage of decline ranged from 15.53% to 58.65% which is similar to the observation of who concluded that the reduction of iron content of yam from 3.25 to 2.52 mg/100 g during boiling.

CONCLUSION

Results revealed that heating and soaking combinations significantly ($P<0.05$) influenced the mineral and oxalate contents of amoche. Both fresh and processed amoche have high amount of oxalate than other root and tuber crops. But it is comparable to many root and tuber crops as a source of minerals. The combination treatments of amoche in soaking with lemon juice pH value of 2.01 and boiling has been found effective in reducing the oxalate in amoche. The reduction of oxalate in this treatment was the highest order of 72.39%. It can be concluded that heat treatment that included boiling after soaking in low pH solvent like in lemon juice pH value of 2.01 can be very helpful in reducing the level of oxalate in amoche.

In view of the present finding it is recommended that, areas where amoche is already consumed as an alternate food need to be educated about the processing techniques which reduces the content of oxalate in the amoche. Boiling and soaking in low pH solvents like lemon juice can be a better option of processing. The quantity of amoche to be consumed daily should not exceed the recommended limits (50 to 100 mg/100 g oxalate for 2500 Kcal/day). Keeping these levels as a base the consumption can be worked out taking into consideration oxalate content of 268 mg/100 g.

ACKNOWLEDGEMENTS

The authors thank Dr. G. H. Shah and Prof. Mary Murimi, Department of Food Science and Postharvest Technology and Department of Chemistry, Arba Minch University, Ethiopia for financial sponsor, and Ethiopia Public Health Research Institute, Addis Ababa, Ethiopia providing the facilities for oxalate analysis.

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