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Studies on Effects of Processing on Oxalate Content in Agricultural Produce (Colocasia esculenta, Prunus dulcis, Glycine max)

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Abstract

In this study chemical composition of three different types of higher oxalate content agricultural produce such as taro- Colocasia esculenta (vegetable) , soybean - Glycine max (legume), almond – Prunus dulcis (nut) were analyzed. Simple and technological processing methods such as soaking in normal water at room temperature and dry heat treatment at 65˚C were applied for almond. Blanching and pressure cooking were applied for taro. Soaking in hot water and maintaining temperature at 55˚C followed by pressure cooking was adopted for soybean. After subjecting the samples for processing they were investigated for biochemical compounds. Comparative study was carried out between chemical composition and oxalate content of these agricultural produce. Maximum reduction in the content of oxalate of up to 50% was noticed in the studied samples after subjecting for processing. The most preferable methods also found out after making the comparative studies among all processing for each and individual. For taro (Colocasia esculenta) the pressure cooking for 7min. and blanching at temperature 65˚C for 1hr were preferred. For almond (Prunus dulcis) soaking for 8hr in cold water at room temperature and dry heating at 65˚C for 5min were preferred. In case of soybean (Glycine max) combined effect of soaking in hot water and pressure cooking for 9 min is preferred.

Key words: *Oxalate, Processing methods, Kidney stones and Food safety.*

Introduction

Oxalate belongs to a group of molecules called organic acids, and is routinely synthesized by plants and animals. In human physiological system, our body cells periodically synthesize oxalate from pre existing precursors like vitamin C: vitamin C is one substance that our cells routinely convert into oxalates. In addition oxalate can arrive at our body from dietary sources. Some plant foods such as silver beet, spinach and rhubarb stalks are well known to contain oxalates (Savage et al., 2000), which are recognized as inhibitors of mineral bioavailability.

The role of oxalate in autism and chronic disorders: Oxalates (the salt form of oxalic acid) are extremely painful when deposited in the body. About eighty percent of kidney stones are caused by oxalate and they are by far most common factor in kidney stone formation. There is also a large degree of genetic variability in the ability to detoxify the chemicals that produce oxalates. Perhaps twenty percent of the population has a genetic variance that increases their likelihood of producing oxalates, even when not consuming high oxalate diets. It has been observed that many children with autism urinate perhaps fifty times a day, but only release a small amount of urine each time. It is because of these children were suffering from kidney stones and high oxalate concentrations. In addition, rather than acting antioxidants, oxalates are prooxidants, so they encourage the oxidation of fats, forming rancid fats in bodies (William Shaw, 2010).

Colocasia esculenta, commonly referred to as taro, is a tropical root crop produce starch storage corms and have several genera and species throughout the world. Investigations showed that taro contain digestible starch, protein of good quality (4%), vitamin C, thiamine, riboflavin, niacin and have high score of proteins and essential amino acid and 390C per 100g of DM (Onayemi and Nwigwe, 1987). One of the major limiting factors in the utilization of taro is the presence of oxalates which impart

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acrid taste or cause irritation when food prepared from that. Ingestion of foods containing oxalates have also been reported to have caustic effect, exert irritations to the intestinal tract and cause absorptive poisoning (Sakai, 1979). The almond, Prunus dulcis, is a species of tree native to the Middle East and South Asia. Vegetarians have valued nuts as an alternative source of protein. In a cohort study, regular consumption of nuts has been associated with a reduced risk of both fatal ischaemic heart disease and non-fatal myocardial infarction (Hu et al., 1998). Nuts are often recommended as a part of a healthy diet but people who have the tendency to form kidney stones are sometimes warned that nuts may contain oxalates.

The soybean, Glycine max, is a species of legume native to East Asia. Human consumption of soybeans and products made from them is increasing. Soybeans are regarded as a highly nutritious food source because of their excellent oil (61% polyunsaturated fat and 24% monounsaturated fat) and protein (eight essentials amino acids) contents. The U.S. Food and Drug Administration have recently approved a label health claim that foods containing at least 6.25 g of soy protein per serving reduce the risk of cardiovascular disease. Besides these nutritional benefits, soybean seeds are rich in isoflavones, compounds that are being studied for their potential of reducing bone loss and breast cancer. Even though there are many studies dealing with the phytate content in seeds and its binding with calcium the nutritional consequences of the oxalate (Ox) content of soybeans and its binding with calcium have been overlooked.

Material and Methods

2.1. Agricultural products

Agricultural produce such as taro (Colocasia esculenta), soybean (Glycine max) and almond (Prunus dulcis) were procured from local market, Kattankulathur, Tamil Nadu. (Figure:1).

2.2. Chemicals

The chemicals were purchased from Merck Co. India and all chemicals and solvents used were analytical grade and were made in India.

2.3. Biochemical analysis

Fresh raw samples such as taro (Colocasia esculenta), almond (Prunus dulcis) and soybean (Glycine max) were taken to analyse moisture, ash content, crude protein content, mineral content (Ca, P and Fe) and oxalate content. Biochemical analysis such as oxalate, protein, calcium, phosphorus, iron was evaluated after processing of each of the agricultural products. Moisture content, ash content, mineral (Ca, P and Fe) were estimated as described by Ranganna (1986). Estimation of protein content was described by Lowry et al., 1951. Oxalate content was estimated by Baker (1952).

2.3.1. Moisture content

Moisture in agricultural produce was determined, according to the Ranganna(1986), by drying 2–5 g sample in an hot air oven set at temperature 105˚C until constant weight.

2.3.2. Ash content

Ash is analyzed in muffle furnace taking 5g of sample in crucible & heating at temp 4000C for 4 hour.

2.3.3. Protein content

The extraction and estimation of protein from three different agricultural produce were carried out by Lowry method. Extraction is usually carried out with buffers used for the enzyme assay. 0.5g. of the sample weighed and grinded well with a mortar and pestle in 5-10 ml. of the buffer. It was centrifuged. The supernatant is used for protein estimation.

2.3.4. Calcium content

Calcium is analyzed by titrimetric method, according to Ranganna (1986), Calcium is precipitated as calcium oxalate. The precipitate is dissolved in hot dilute H2SO4 and titrated with standard potassium permanganate.

2.3.5. Phosphorus content

Phosphorus is analyzed by colorimetric method according to Ranganna (1986). 5ml of ash solution obtained by dry ashing, 5ml. of molybdate reagent was added and mixed. 2ml. of aminonaphthosulphonic acid solution was added with constant mixing and it was made up to 50ml. Similarly a blank was prepared by using water instead of the sample. It was allowed to stand for 10 minute and measured the colour at 650 nm setting the blank at 100% transmission.

Figure-1: Agricultural produce

a. Taro (Colocasia esculenta)

b. Soybean (Glycine max)

c. Almond (Prunus dulcis)

2.3.6. Iron content

Iron content is analyzed by colorimetric method according to Ranganna (1986). The iron is determined by converting the iron to ferric form using oxidising agents like potassium persulphate on hydrogen peroxide and treating thereafter with potassium thiocyanate to form the red ferric thiocyanate which is measured colorimetrically at 480nm setting the blank at 100% transmission.

2.3.7, Oxalate content

Oxalate is analyzed according to Baker (1952). The oxalate is extracted from agricultural produce and precipitated as calcium oxalate which is then titrated against standard potassium permanganate.

2.4. Processing methods

The taro was washed properly with running water. After removing the peel it was taken for estimation. Taro-samples were subjected to processing such as blanching for 1hr at temperature 600C, 650C and 700C and followed by pressure cooking for 5min, 7min and 9min. While soaking in hot water (55˚C) at different time intervals like 2h, 4h and 6h followed by pressure cooking at 5min, 7min and 9min was carried out for soybean. Dry heating for 5minute, 7minute and 9minute at temperature 650C and soaking in cold water at room temperature for time intervals 6hr, 8hr and 10hr were adopted for almond.

2.5. Statistical analysis

Oxalate, total protein and mineral (calcium, phosphorus, iron) contents were estimated on triplicate determinations. Estimates of mean and standard error for the aforesaid parameters were calculated.

Results and Discussion

Three different variety of high oxalate rich agricultural product were estimated along with their chemical composition such as protein, calcium, phosphorus and iron. The various processing methods applied used to reduce the oxalate level by approximately 50%. The greatest reduction i.e. 75.29% was observed for the combined effect of soaking in hot water at 55˚C and pressure cooking for soybean (Glycine max). Along with that some other biochemical analysis has been carried out. The most preferable methods also found out after making the comparative studies among all processing for each and individual. For taro (Colocasia esculenta) the pressure cooking for 7minute and blanching at temperature 65˚C for 1hr were preferred. For almond (Prunus dulcis) soaking for 8hr in cold water at room temperature and dry heating at 65˚C for 5minute were preferred. In case of soybean (Glycine max) combined effect of soaking in hot water and pressure cooking for 9minute is preferred.

People suffering from high risk of coronary heart diseases are encouraged to consume 60g nuts per day and this can give a positive effect on the reduction in risk from ischaemic heart disease. The consumption of this amount of nut species could lead to modest increase in oxalate intake. While ischaemic heart disease is a serious medical problem it is important to minimize the potential of preventive strategies to cause other medical problems. So by applying such above preferred method (Soaking of almond for 8hr and dry heating at temp 650C for 5minute) a person can avoid the toxic effect of oxalate. High oxalate foods should be cooked to reduce the oxalate content. So the preferred method of pressure cooking gives best effect on reduction of oxalate as well as the moderate loss of protein, minerals such as calcium, phosphorus and iron.

The conclusion of this study is to provide food safety issue to public regarding high oxalate diets which produces kidney stones and people who have a tendency to form kidney stones would be wise to moderate their consumption of such high oxalate agricultural products.

Table-1: Effect of pressure cooking on taro (Colocasia esculenta)

Agricultural produce	Time (min)	Ox(g/100g)	Ox loss (%)	Protein (g/100g)	Protein loss (%)	Ca (g/100g)	Ca loss (%)	P (g/100g)	P loss (%)	Fe (g/100g)	Fe loss (%)
Raw	0	0.16 ± 0.02		8.1 ± 0.02		0.14 ± 0.04		0.06±0.06		0.04±0.01	
Processed	5	0.09 ± 0.02	40.18	6.0 ± 0.02	25.8	0.13 ± 0.01	2.14	0.05±0.02	3.33	0.04±0.08	2.38
	7	0.09 ± 0.02	44.72	5.9 ± 0.01	26.91	0.13 ± 0.05	3.57	0.05±0.01	10	0.03±0.02	9.52
	9	0.06 ± 0.02	58.58	5.1 ± 0.01	36.66	0.13 ± 0.02	5	0.05±0.08	13.33	0.03±0.01	19.04

Table-2: Effect of Blanching on taro (Colocasia esculenta)

Agricultural produce	Temp (°C)	Ox(g/100g)	Ox loss (%)	Protein (g/100g)	Protein loss (%)	Ca (g/100g)	Ca loss (%)	P (g/100g)	P loss (%)	Fe (g/100g)	Fe loss (%)
Raw	25	0.16±0.02		8.1±0.02		0.14±0.04		0.06±0.006		0.04±0.01	
	60	0.12±0.04	25.76	5.00±0.02	38.27	0.13±0.03	2.85	0.05±0.002	15	0.03±0.03	9.52
Processed	65	0.10±0.05	35.58	6.11±0.03	24.56	0.13±0.01	3.57	0.05±0.002	8.33	0.04±0.08	4.76
	70	0.10±0.01	38.03	4.45±0.04	45.06	0.12±0.03	12.14	0.04±0.001	18.33	0.03±0.01	11.9

Table-3: Effect of soaking on almond (Prunus dulcis)

Agricultural produce	Time (hr)	Ox(g/100g)	Ox loss (%)	Protein (g/100g)	Protein loss (%)	Ca (g/100g)	Ca loss (%)	P (g/100g)	P loss (%)	Fe (g/100g)	Fe loss (%)
Raw	0	0.32±0.02		22.6±0.02		0.16±0.04		0.21±0.02		0.03±0.02	
	6	0.15±0.01	53.25	18.85±0.01	16.59	0.15±0.01	1.87	0.20±0.01	1.41	0.03±0.04	2.77
Processed	8	0.13±0.02	58.2	18.95±0.03	16.15	0.15±0.02	3.75	0.20±0.03	5.18	0.03±0.02	3.88
	10	0.12±0.02	62.53	18.51±0.02	18.09	0.15±0.03	4.37	0.19±0.01	7.07	0.03±0.01	4.44

Table-4: Effect of dry heating on almond (Prunus dulcis)

Agricultural produce	Time (min)	Ox(g/100g)	Ox loss (%)	Protein (g/100g)	Protein loss (%)	Ca (g/100g)	Ca loss (%)	P (g/100g)	P loss (%)	Fe (g/100g)	Fe loss (%)
Raw	0	0.32± 0.02		22.61±0.02		0.16±0.04		0.21±0.02		0.03±0.02	
	5	0.16±0.03	49.84	17.33±0.03	23.31	0.15±0.01	3.12	0.20±0.02	3.77	0.03±0.02	1.11
Processed	7	0.13±0.03	57.27	16.41±0.01	27.38	0.15±0.02	3.75	0.20±0.01	4.71	0.03±0.01	1.38
	9	0.13± 0.02	58.82	14.36±0.02	36.46	0.14±0.04	6.87	0.19±0.01	6.6	0.03±0.01	5.83

Table-5: Combined effect of soaking at 55˚C for 2h and pressure cooking of soybean (Glycine max)

Agricultural produce	Time (min)	Ox(g/100g)	Ox loss (%)	Protein (g/100g)	Protein loss (%)	Ca (g/100g)	Ca loss (%)	P (g/100g)	P loss (%)	Fe (g/100g)	Fe loss (%)
Raw	0	0.25± 0.02		30.06±0.04		0.16± 0.04		0.26±0.01		0.02±0.02	
	5	0.13± 0.03	47.05	27.06± 0.04	9.98	0.16± 0.03	1.82	0.26±0.04	1.86	0.02±0.02	2.34
Processed	7	0.12± 0.01	52.94	22.21± 0.04	26.11	0.15± 0.01	4.26	0.26±0.02	2.98	0.02±0.01	2.73
	9	0.10± 0.02	58.82	17.33± 0.01	42.34	0.15±0.04	4.8	0.25±0.04	3.35	0.02±0.03	6.25

Table-6: Combined effect of soaking at 55˚C for 4h and pressure cooking of soybean (Glycine max)

Agricultural produce	Time (min)	Ox(g/100g)	Ox loss (%)	Protein (g/100g)	Protein loss (%)	Ca (g/100g)	Ca loss (%)	P (g/100g)	P loss (%)	Fe (g/100g)	Fe loss (%)
Raw	0	0.25±0.02		30.06±0.04		0.16±0.04		0.26±0.01		0.02±0.02	
	5	0.08±0.01	68.23	16.56±0.02	44.91	0.15±0.04	4.87	0.26±0.02	2.23	0.02±0.01	8.21
Processed	7	0.06±0.02	72.94	16.81±0.01	44.07	0.14±0.02	12.19	0.25±0.02	3.35	0.02±0.01	9.37
	9	0.06±0.03	74.11	14.26±0.01	52.56	0.14±0.01	12.8	0.25±0.01	4.47	0.02±0.01	10.15

Table-7: Combined effect of soaking at 55˚C for 6h and pressure cooking of soybean (Glycine max)

Agricultural produce	Time (min)	Ox(g/100g)	Ox loss (%)	Protein (g/100g)	Protein loss (%)	Ca (g/100g)	Ca loss (%)	P (g/100g)	P loss (%)	Fe (g/100g)	Fe loss (%)
Raw	0	0.25±0.02		30.06±0.04		0.16±0.04		0.26±0.001		0.02±0.002	
	5	0.07±0.02	69.41	14.21±0.02	52.72	0.14±0.02	14.02	0.24±0.001	7.08	0.02±0.01	21.48
Processed	7	0.06±0.04	74.11	13.75±0.02	54.25	0.13±0.03	20.12	0.24±0.004	9.7	0.01±0.02	25.78
	9	0.06±0.01	75.29	12.66±0.03	57.88	0.12±0.02	21.34	0.23±0.003	10.82	0.01±0.01	27.73

Values are mean of three replicates, ± Standard error

Conclusion

Three different variety of high oxalate rich agricultural product were estimated along with their chemical composition such as protein, calcium, phosphorus and iron. The various processing methods applied used to reduce the oxalate level by approximately 50%. The greatest reduction i.e. 75.29% was observed for the combined effect of soaking in hot water at 55˚C and pressure cooking for soybean (Glycine max). Along with that some other biochemical analysis has been carried out. The most preferable methods also found out after making the comparative studies among all processing for each and individual. For taro (Colocasia esculenta) the pressure cooking for 7minute and blanching at temperature 65˚C for 1hr were preferred. For almond (Prunus dulcis) soaking for 8hr in cold water at room temperature and dry heating at 65˚C for 5minute were preferred. In case of soybean (Glycine max) combined effect of soaking in hot water and pressure cooking for 9minute is preferred.

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