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Fatty acid composition of underutilized corms, rhizomes and tubers

Tresina, P.S., Doss, A. and *Mohan, V.R.

Ethnopharmacology Unit, V.O.Chidambaram College, Thoothukudi - 628 008, Tamil Nadu, India

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Abstract

With escalating populace pressure and fast exhaustion of natural resources, it has become extremely vital to diversify the present time agriculture with the cultivation of some wild varieties of tubers, rhizomes and corms in order to meet various human nutrient needs. However, information regarding fatty acid composition is inadequate. The purpose of the present study was to examine the fatty acid composition of six samples of wild corms (*Alocasia macrorrhiza*, *Amorphophallus paeoniifolius* var. c*ampanulata*, *A. sylvaticus*, *Colocasia esculenta*, *Xanthosoma sagittifolium*, *X. violaceum* two species of rhizomes (*Canna indica* and *Maranta arundinacea*) and three species of tubers (*Asparagus racemosus*, *Nymphaea pubescens* and *N. rubra*) in order to assess the nutritional and biochemical significance. The total lipid was extracted from the corms, rhizomes and tubers using chloroform and methanol mixture in the ratio of 2:1 (w/v). Methyl esters were prepared from the lipids. Fatty acid analysis was performed by gas chromatography. Among the investigated species, corm of *X. sagittifolium* registered the highest amount of palmitic acid. Similarly, tubers of *A. racemosus* exhibited the highest amount of linoleic acid. The present investigation demonstrated that the corms, rhizomes and tubers act as a good source of fatty acid.

1. Introduction

India has one of the major concentrations of tribal population in the world. Forest plays a vital role in the economy as well as in the daily needs of the tribals. In times of resources when the staple food is in short supply, the tribals collect many types of wild roots and tubers to supplement their meagre food available at home (Vidyarthi, 1987). Roots and tubers refer to any growing plant that store edible material in the subterranean root, corm and tubers. The nutritional value of roots and tubers lies in their prospective ability to provide one of the best and cheapest sources of nutritional energy in the form of carbohydrates in expanding countries (Ugwu, 2009).

In India the cooked wild corms, rhizomes and tubers are known to be consumed by the Palliyar tribals living in Grizzled Giant Squirrel Wildlife Sanctuary, Srivilliputhur and Kanikkars living in the Agasthiarmalai Biosphere Reserve, Kanyakumari and Tirunelveli Districts, South-Eastern Slopes of Western Ghats, Tamil Nadu (Arinathan *et al*., 2007; Shanthakumari *et al*., 2008; Shajeela *et al*., 2011). Information regarding the chemical and nutritional content of wild edible corms, rhizomes and tubers are meagre (Babu *et al*., 1990; Nair and Nair, 1992; Rajalakshmi and Geervani, 1994; Bhandari *et al*., 2003; Udensi *et al*., 2008; Alozie *et al*., 2009; Arinathan *et al*., 2009; Mohan and Kalidass, 2010; Shajeela *et al*., 2013). Reports on fatty acid contents of other common varieties of yam and wild yam are available (Opute and Osagie, 1978; Kouassi *et al*., 1988; Muzac-Tucker *et al*., 1993; Alzoie *et al*., 2010; Shajeela *et al*., 2013). However, their fatty acids may be beneficial to human beings, since plant fatty acids have become a major player in the alleviation of most human diseases. For the first time in the present investigation, an attempt was made to understand the fatty acid composition of underutilized corms, rhizomes and tubers.

2. Materials and methods

2.1 Plant sample

Six samples of wild corms (*Alocasia macrorrhiza* Schott, *Amorphophallus paeoniifolius* (Dennst) Nicolson var. *campanulata* (Blume ex Decne) Sivadasam, *A. sylvaticus* (Roxb.) Kunth, *Colocasia esculenta* (L.) Schott, *Xanthosoma sagittifolium* (L) Schott *X.*

*Corresponding author.
Email: *vrmohanvoc@gmail.com*

violaceum Schott, two species of rhizomes (*Canna indica* L, *Maranta arundinacea* (L.) and three species of tubers (*Asparagus racemosus* Willd, *Nymphaea pubescens* Willd, and *N. rubra* Roxb ex Andrews) grown in sandy loam soil are consumed by the tribals Kanikkars/Palliyars were collected using multistage sampling technique in three consecutive rainy seasons during August and January 2016 from the South Eastern slopes of Western Ghats, Virudhunagar district, Kanyakumari district and Tirunelveli district, Tamil Nadu. The plant specimens were identified with the help of local flora and authenticated by Botanical Survey of India (Southern Circle) Coimbatore. The collected corms, rhizomes and tubers were weighed, peeled, cut into small pieces and dried at 40℃ until the content weight was obtained. The dried samples were ground to a time powder by Willy mill. The powdered samples were stored in screw cap bottles at room temperature for further analysis.

2.2 Lipid extraction and fatty acid analysis

The total lipid was extracted from the corms, rhizomes and tubers according to the method of Folch *et al*. (1957) using chloroform and methanol mixture in the ratio of 2:1 (v/v). Methyl esters were prepared from the total lipids by the method of Metcalfe *et al*. (1966). Fatty acid analysis was performed by gas chromatography (ASHMACO, Japan; Model No: ABD20A) using an instrument equipped with a flame ionization detector and a glass column (2mx3mm) packed with 1% diethylene glycol succinate on chromosorb W. The temperature conditions for GC were injector 200°C and detector 210° C. The temperature of the oven was programmed from 180°C and the carrier gas was nitrogen at a flow rate of 30 ml/min. Peaks were identified by comparison with authentic standards, quantified by peak area integration and expressed as the weight percentage of total methyl esters; the relative weight percentage of each fatty acid was determined from integrated peak areas.

3. Results and discussion

The results of crude fat content and fatty acid composition of wild corms *Alocasia macrorrhiza, Amorphophallus paeoniifolius* var. *campanulata*, *A. sylvaticus, Colocasia esculenta, Xanthosoma sagittifolium X. violaceum, rhizomes Canna indica Maranta arundinacea* and tubers *Asparagus racemosus, Nymphaea pubescens* and *N. rubra* are presented in Tables 1 and 2. The data showed that the crude fat content of the wild corms, rhizomes and tubers ranged from 2.38% to 7.10%. The fatty acid composition of underutilized corms, rhizomes and tubers ranged from 1.5% to 34.31%. The results showed palmitic acid (24.26 – 31.57%), oleic acid (11.08 – 19.04%) and linoleic acid (28.36 – 34.31%) as the predominant fatty acid in the underutilized corms, rhizomes and tubers. The most abundant saturated fatty acid was palmitic acid. Similarly, the most abundant unsaturated fatty acid was linoleic acid. Among the species investigated, corms of *Xanthosoma sagittifolium* contained a high amount of palmitic acid (31.57%). Similarly, tubers of *Asparagus racemosus* contained a higher amount of linoleic acid (34.31%). All the investigated corms, rhizomes and tubers exhibited a higher level of unsaturated fatty acids. The polyunsaturated to saturated fatty acids (P/S) ratio varies in the range from 0.95 and 1.24.

The fatty acid composition of the various species of corms, rhizomes and tubers investigated in the present study was found to be in agreement with earlier reports in the tubers of *Dioscorea alata* (Ciacao and D'Appolonia, 1978); *D. transversa* (Brown *et al*., 1985); *D. dumetorum* varieties (Kouassi *et al*., 1988); *D. tomentosa* wild and edible (Alozie *et al*., 2010); *Dioscorea* spp. (Shajeela *et al*., 2011). Similarly, all the investigated corms, rhizomes and tubers contained more amount of unsaturated fatty acid linoleic. This is in consonance with an earlier report in the tubers of *D. alata* and *D. kifida* (Muzac-Tucker *et al*., 1993). The unsaturated ratio of the investigated corms, rhizomes and tubers is lower than the values reported earlier of *D. alata* (1:4), *D. bulbifera* (1:4), *D. rotunda* (1:8), *D. cayenencis* (1:8) (Opute and Osagie, 1978) and *D. dumetorum* (Alozie *et al*., 2010). Palmitic acid was the controlling saturated fatty acid, tracked by the unsaturated fatty acid, linoleic acid. Among the investigated corms, rhizomes and tubers, corms of *Xanthosoma sagittifolium* contained more amount of palmitic acid and tubers of *Asparagus racemosus* contained higher amount of linoleic acid when compared with other presently investigated species. Unsaturated fatty acids, particularly linolenic acid is required for normal functioning of the human body. The nutritional value of linoleic acid is due to its metabolism at tissue levels which produce hormone like prostaglandins. The ability of these prostaglandins includes lowering of blood pressure and construction of smooth muscle (Aurand *et al*., 1987). Linoleic and linolenic acids are the most important essential fatty acids required for growth, physiological functions and maintenance (Pugalenthi *et al*., 2004). The fatty acids composition and high amount of unsaturated fatty acids make corms, rhizomes and tubers suitable for nutritional applications. The presence of high levels of unsaturated fatty acids in all the presently investigated corms, rhizomes and tubers are nutritionally desirable. Plant fatty acids serve as good and healthy fat to the consumer and the low incidence of coronary heart disease (Alozie *et al*., 2009). The O/L

Table 1. Fatty acid composition of underutilized corms

Crude fat/ Fatty acids (%)	*Alocasia macrorrhiza*	*Amorphophallus paeoniifolius var. campanulata*	*A. sylvaticus*	*Colocasia esculenta*	*Xanthosoma sagittifolium*	*X. violaceum*
Crude fat (%)	2.38	5.58	4.98	4.13	6.1	4.26
Myristic acid (C14:8)	-	-	-	-	2.46	3.28
Palmitic acid (C16:0)	26.3	29.34	26.76	27.26	31.57	28.88
Palmitic acid (C16:1)	3.28	4.36	2.36	4.41	1.04	-
Stearic acid (C18:0)	7.48	9.42	11.34	8.46	12.14	9.42
Oleic acid (C18:1)	14.36	18.3	19.04	12.06	11.08	12.76
Linoleic acid (C18:2)	32.3	28.36	29.04	32.4	29.46	31.33
Linolenic acid (C18: 3)	14.02	8.26	9.02	13.24	10.1	9.41
Others	2.26	1.96	2.44	2.17	2.15	4.92
Unsaturated ratio*	1.18	0.97	1.06	1.14	0.95	1.06
O/L ratio*	0.44	0.65	0.73	0.37	0.38	0.4

All values are of two determinations. *O/L ratio means: Oleic acid/Linoleic acid

Table 2. Fatty acid composition of underutilized rhizomes and tubers

Crude fat/ Fatty acids (%)	*Canna indica*	*Maranta arundinacea*	*Asparagus racemosus*	*Nymphaea pubescens*	*N. rubra*
Crude fat (%)	3.05	2.78	7.10	3.78	5.10
Myristic acid (C14:8)	2.18	-	-	-	-
Palmitic acid (C16:0)	27.18	24.26	26.08	28.04	30.39
Palmitic acid (C16:1)	3.48	3.01	2.36	2.04	-
Stearic acid (C18:0)	9.52	12.21	7.42	10.09	12.74
Oleic acid (C18:1)	13.06	14.26	11.46	12.41	13.26
Linoleic acid (C18:2)	29.46	31.46	34.31	29.32	30.14
Linolenic acid (C18: 3)	13.04	13.3	15.46	14.44	12.1
Others	2.08	1.5	2.91	3.66	1.37
Unsaturated ratio*	1.06	1.19	1.24	1.03	0.99
O/L ratio*	0.44	0.45	0.33	0.42	0.44

All values are of two determinations. *O/L ratio means: Oleic acid/Linoleic acid

ratio of lipids of presently investigated samples is lower in comparison with the average suggested earlier (Attia *et al*., 1996).

The role of fatty acid especially the polyunsaturated fatty acids (PUFAs) in the management of coronary heart disease can be considered as the function of fatty acid of plant origin. PUFAs is known to regulate prostaglandin synthesis, thus promoting wound healing activity that cannot be synthesized by man and must be obtained from the diet. It has been reported that dietary changes achieved greater reductions in cardiovascular risk factors and coronary heart disease mortality in a secondary prevention trial than any of the cholesterol-lowering studies to date. The consumption of corms, rhizomes and tubers will, therefore, supplement dietary fat with such essential fatty acids of linoleic acid and others which are high in these plants.

4. Conclusion

The present study confirms that the corms, rhizomes and tubers can act as a good resource of fatty acid. However, their fatty acids may be beneficial to human beings and animals since plant fatty acids have become a major player in the alleviation of most human diseases. The findings of this study thus open us to new areas of research in the utilization of these plants in functional food production.

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