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NOTE

Nutritive value of rhizome of the ginger resembling *Alpinia allughas* Rosc. and characteristics of various extracted materials from the rhizome

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Abstract : Looking to the important medicinal value of the rhizome of *Alpinia allughas* Rosc., the nutritive value of the rhizome is determined. Rhizome is rich in carbohydrate (71.7%) and has enough protein and crude fibre (9.6 and 9.1% respectively); nutritive value being 333.5 Cal/100 g. Rhizome is rich in calcium (856 ppm) and sufficient in sodium and magnesium (77 and 50.5 ppm respectively). Other biologically important metals Cu, Ni, Mn, Fe, Zn and K are also in suitable amounts. Cr seems to be higher than required (30 ppm). The extractions of useful materials separately through solvents of decreasing polarities, viz. water, ethanol, diethyl ether and petroleum ether are carried out from its rhizome. The water extract has maximum yield. Odours vary in differently extracted materials. Petroleum ether extracted material shows a sufficient degree of unsaturation. All of the solvent extracted materials are dextro rotatory. Specific gravities, refractive indices, acid, saponification and iodine values of these variously extracted materials are also reported. Tests for the presence of specific natural products indicate the presence of alkaloids, carbohydrates, steroids and flavonoids in most of the materials.

Keywords : *Alpinia allughas, Alpinia nigra, Zingiber nigrum*, Zingiberaceae, nutritive value.

Introduction

The plant *Alpinia allughas* (syn. *Alpinia nigra, Zingiber nigrum*) belongs to zingiberaceae family. It is known as *Taraka* in Sanskrit[1]. It grows naturally in some parts of North-Eastern India and cultivated mostly in South Konkan[2]. It also occurs in some parts of Sri Lanka, Bhutan and Thailand. Its rhizomes are used in rheumatism, bronchial catarrh and in dyspepsia etc. They are also useful in respiration troubles, especially of children[2]. The plant is also known for its fibre quality and paper making[3]. Reports on some work on essential oil composition from the fruits/rhizomes/leaves are available[4-6]. Five chemical constituents have been isolated[7] from the seed cluster of the plant The aqueous solution of the rhizome of *A. allughas* has a good antibacterial activity[8] against Streptococcus and Staphylococcus spp. Alcoholic extract of the shoot is reported to have flukicidal activity[9]. Certain pharmacognostical studies on the rhizomes of a Chinese sample have been carried out by Chunfeng *et al.*[10]. The dichloromethane/methanol extract of the rhizome shows good antioxidant activity[11,12].

Looking to the variety of uses, the determination of nutritive value of rhizome and a detailed study of physicochemical properties of the various solvent extracted materials from the rhizomes and determination of natural product groups seem to be important. Nutritive value of plants has its own importance. Carbohydrates, fats and proteins form the major portion of the diet, while minerals form comparatively a smaller but never a less important part[13]. In view of the developing awareness towards importance of various biologically important metals in our body, a study towards the presence of such metals in *A. allughas* rhizome is also conducted in the present work.

Results and discussion

Results of the presence of various mineral and trace elements in rhizome are given in Table 1. The results of nutrition related values are given in Table 2, which are the average of three runs carried out for each. Yields and

Table 1. Concentrations of some biologically important elements in the rhizome (in ppm)

Cr	Mn	Fe	Ni	Cu	Zn	Mg	Ca	Na	K
30.0	3.6	14.6	10.1	2.0	1.1	50.5	856	77.0	10.0

physico-chemical properties of extracted materials are described in Table 3, while the results of the presence of specific natural products are summarized in Table 4.

Table 2. Nutritive and related values of *Alpinia allughas* rhizome

	1st expt.	2nd expt.	3rd expt.	Average
Ash content (%)	3.18	3.24	3.18	3.20
Moisture content (%)	14.66	14.60	14.54	14.60
Crude fat (%)	0.94	0.94	0.94	0.94
Crude protein (%)	9.54	9.64	9.50	9.58
Carbohydrate (%)	71.68	71.58	71.84	71.70
Crude fibre (%)	9.11	9.13	9.12	9.12
Nutritive value (Cal/100 g)	333.34	333.34	333.82	333.50

Among the various biologically important metals. magnesium and calcium are required in sufficient quantity by human body and in the studied material they are enough (Mg 50.5 ppm, Ca 856 ppm). Mg has electrochemical and enzyme activating functions[14]. It is required in the plasma and extracellular fluid, where it helps to maintain osmotic equilibrium. It is required in many enzyme-catalysed reactions, especially those in which nucleotides participate where the reactive species is the magnesium salt, e.g. $MgATP^{2-}$. Lack of Mg is associated with abnormal irritability of muscle and convulsions and excess Mg is associated with depression of the central

Table 3. Results of the analyses of materials obtained by extraction through solvents of different polarities

Properties	Material extracted through			
	Petroleum ether	Diethyl ether	Ethanol	Water
Colour of decoction	Reddish brown	Light yellow	Dark brown	Dark brown
Colour of extracted material	Brown	Yellow	Blackish	Dark brown
State	Viscous oil	Solid	Solid	Solid
Odour	Characteristic sharp	Characteristic sharp	Characteristic sharp	Unpleasant
Yield (%, w/w)	0.94	1.94	1.84	5.44
pH	6.40	5.10	5.30	6.40
Refractive index (0.025% solution)	1.36̊	1.35	1.32	1.42
Specific gravity (30°/30°)	0.974	-	-	-
Optical rotation (25 °C) (0.025% solution)	+2°03′	+0°50′	+5°03′	+2°58′
Acid value	19.4	33.7	12.8	29.9
Saponification value	80.1	67.3	63.1	78.5
Iodine value	50.8	26.7	38.1	22.9

Table 4. Results of the analyses of extracted materials for different specific natural products

Specific natural products	Material extracted through			
	Petroleum ether	Diethyl ether	Ethanol	Water
Carbohydrates				
Molisch test	-ve	-ve	+ve	+ve
Alkaloids				
Mayor's test	+ve	+ve	-ve	+ve
Steroids				
Salkowski reaction	-ve	+ve	+ve	+ve
Carotenoids				
Sulphuric acid test	-ve	-ve	-ve	-ve
Flavonoids	-ve	+ve	+ve	+ve
Proteins				
Xanthoproteic test	-ve	+ve	+ve	-ve
Biuret test	-ve	+ve	+ve	-ve

nervous system. Quantity of Ca is highest amongst all the metals in *A. allughas* rhizomes. Ca constitutes a large proportion of the bone, human blood and extracellular fluid; it is necessary for the normal functioning of cardiac muscles, blood coagulation and milk clotting, and the regulation of cell permeability. It also plays an important part in nerve-impulse transmission and in the mechanism of neuromuscular system. Another two important metals are sodium and potassium. They take part in ionic balance of the human body and maintain tissue excitability. Because of the solubility of salts, Na plays an important role in the transport of metabolites. K is of importance as a diuretic and helps lower elevated blood pressure. Both are in suitable amounts in the studied material (Na 77 ppm, K 10 ppm). Among the determined metals, the percentage of zinc is lowest (1.1 ppm) fol-

lowed by copper (2.0 ppm) in the rhizomes of *A. allughas*. In fact, the percentage of Zn in *A. allughas* rhizome is even slightly lower and that of Cu is slightly higher than what in the other reported Alpinia species[15]. Cu is helpful in reducing the symptoms of rheumatoid arthritis. Alongwith Mn, it helps in disarming free radicals[16]. Also, Cu is a component of many enzyme systems such as cytochrome oxidase, lysyl oxidase and ceruloplasmin, an iron oxidizing enzyme in blood[17]. The observation of anaemia in Cu deficiency may probably be related to its role in facilitating iron absorption and in the incorporation of iron into haemoglobin[18]. Zn is a component of many metalloenzymes, including some enzymes which play a central role in nucleic acid metabolism[19]. In addition, Zn is a membrane stabilizer and a stimulator of the immune response[20]. Its deficiency leads to impaired growth and malnutrition[21]. Zn prevents even some of the serious infections seen in patients with advanced or long-standing diabetes[16]. Amount of chromium is surprisingly high (30 ppm). Though Cr plays a vital role in metabolism of carbohydrates and its deficiency leads to diabetes[22], hyperglycaemia, growth failure, cataract and atherosclerosis[23], but in *A. allughas* rhizome it seems to be higher than what is required. Iron is just the moderate (14.6 ppm). Importance of iron is well known. Manganese is also quite low (3.6 ppm). Mn is essential for haemoglobin formation[24], but excess is harmful. Nickel is sufficiently high in rhizomes of *A. allughas* (10.1 ppm). It is an active metal in several hydrogenases and plant ureases. Chicks and rats raised on deficient Ni diet show impaired liver function and morphology[14].

The nutritive value of the rhizome is very good (333.50 Cal/100 g). As expected, the rhizome is very highly rich in carbohydrates (71.7%). Rhizomes of zingiberaceae species usually have this much high carbohydrates[15]. The percentages of crude protein (9.58%) and crude fibre (9.12%) seem to be quite suitable. Current awareness towards the fibrous food is well known. However, the rhizomes are very low in fat (0.94% only). Good for those who need a low fat but high carbohydrate diet

In *A. allughas* rhizome the maximum yield of the material is found in the water extract that indicates a high proportion of water and hot water soluble substances in the rhizome. These substances seem to be certain aldehydes, ketones, steroids and flavonoids. The next yield is in diethyl ether. Yield in ethanol is slightly less than that in diethyl ether. The yield of the material obtained by extraction through petroleum ether is lowest, indicating the presence of only the small amount of free fatty acids. However, the presence of unsaturated compounds is highest in petroleum ether extracted material as indicated by high iodine value, indicating these free fatty acids to be mostly unsaturated.

Experimental

Authenticated rhizomes of *Alpinia allughas* were procured from Guwahati, and authenticity verified from Forest Research Institute, Dehradun. A voucher specimen has been deposited in the herbarium of Plant Medicine Section of the Chemistry Department of the University under the registry no. 21/15 and available for inspection. The procured rhizomes were washed with luke warm deionized water and dried in shade, grinded to fine powder and used to prepare the samples for mineral analysis[25]. For nutritive value related analyses and for various solvent extractions the coarsely crushed dried rhizome was used.

Analysis of rhizome for mineral and trace elements :

Powdered plant material (rhizome) was taken in a precleaned and constantly weighed silica crucible and heated in a muffle furnace to 400 °C till there was no evolution of smoke. The crucible was cooled at room temperature in a desiccator and carbon-free ash was moistened with concentrated sulphuric acid, heated on a heating mantle till the fumes of sulphuric acid ceased to evolve. Crucible with sulphated ash was then heated in a muffle furnace at 600 °C till the weight of the content was constant (~2 to 3 h). One gram of sulphated ash obtained above was dissolved in 100 mL of 5% HCl to obtain the solution ready for determination of mineral elements through Atomic Absorption Spectroscopy (AAS). Standard solution of each element was prepared and calibration curves were drawn for each, using (Elmer Trans-3100) AAS.

Analysis of rhizome for nutritive value :

For determination of nutritive value, the following parameters were studied by using the crushed rhizome as the sample. Three experiments were made in each case and average taken.

Determination of ash content was carried out by weighing 5.0 g of sample in a silica crucible which had previously been heated to about 600 °C and cooled. The crucible was heated first over a low flame till all the material was completely charred, followed by heating in a muffle furnace for about 3-5 h at 600 °C. It was cooled in a desiccator and weighed. To ensure completion of ashing, the crucible was again heated in a muffle furnace for half an hour, cooled and weighed. The procedure was repeated till two consecutive weights were the same and the ash was almost white or greyish white. Weight of ash gave the ash content[26].

Usual method was adopted for determination of moisture content. 2.0 g of sample material was taken in a flat bottom dish and kept overnight in an air oven at 100-110 °C and weighed. The loss in weight gave the moisture content.

Crude fat was determined by extracting 20.0 g of moisture free sample with petrol in a Soxhlet extractor, heating the flask on a sand bath for about 6 h till a drop taken from drippings left no greasy stain on filter paper. After boiling with petrol, the residual petrol was filtered using Whatman no. 40 filter paper and the filtrate was evaporated in a pre-weighed beaker. Increase in weight of beaker gave crude fat[27].

Crude protein was determined using micro Kjeldahl method. One gram oven dried material was placed in the digestion flask, 10 g of powdered potassium sulphate, 0.5 g of copper sulphate and 25 mL of conc. sulphuric acid were added to it and digestion conducted by placing the flask in an inclined position and heating it below the boiling point of acid for about 5-15 min. The temperature was raised until the acid boiled briskly. A funnel was placed in the mouth of the flask to restrict the circulation of air. Heating was continued till the solution became clear. The contents were cooled and diluted by adding 200 mL of water. 0.5 g of granulated zinc and 50 mL of 40% NaOH solution were added to make the reaction strongly alkaline. The contents were mixed and at once attached to the distillation apparatus. In the receiving flask 25 mL 0.1 *N* sulphuric acid was taken. When two-thirds of the liquid had been distilled, it was tested for completion of reaction. The flask was removed and titrated against 0.1 *N* caustic soda solution using methyl red indicator for determination of Kjeldahl nitrogen, which in turn gave the protein content.

Because of its importance, the crude fibre was determined to be reported along with the nutritive value. For determination of crude fibre, the estimation was based on treating the moisture and fat free material with 1.25% dilute acid, then with 1.25% alkali, thus imitating the gastric and intestinal action in the process of digestion. 2.0 g of the moisture and fat free material was taken in a 400 mL beaker marked at 200 mL level. Added 200 mL of 1.25% H_2SO_4 and boiled for half an hour. After filtration and washing, the residue was treated with 200 mL of 1.25% caustic soda solution. It was filtered, washed with hot water and then 1% HNO_3 and again with hot water. Ignited the residue to get the ash, and weighed. The loss in weight gave the weight of crude fibre[28].

Percentage of carbohydrate was given by :

100 - (% ash + % moisture + % fat + % protein).

Nutritive value was finally determined by :

Nutritive value = (4 × % protein) + (9 × % fat) + (4 × % carbohydrate).

Extraction through solvents :

Extraction through water : 100 g of the crushed rhizome were boiled with doubly distilled water for 1 h. The extract was filtered and water evaporated. 5.44 g dark brown solid material was obtained.

Extraction through ethanol : 100 g crushed material was kept in a sufficient quantity of ethanol in a Soxhlet extractor for 72 h. Dark brown decoction was collected. A fresh quantity of ethanol was added again to the same material and kept for another 72 h. Process was repeated till the extract became colourless. All the extracted solutions were mixed and ethanol separated by vacuum distillation. 1.84 g black solid material was obtained.

Extraction through diethyl ether : Similar procedure, as for ethanol, was carried out. 1.94 g yellowish solid was obtained.

Extraction through petroleum ether : Similar procedure, as for ethanol, was carried out. 0.94 g brown viscous oil was obtained.

Study of properties :

For each extracted material the specific gravity, refractive index, pH and optical rotation were determined and presence of various possible families of natural prod-

uct compounds was tested. Acid, saponification and iodine values were determined using the methods described by Garratt[29], Guenther[30] and in monographs of ISI[31]. The presence of various possible specific natural products alkaloids, proteins, flavonoids, carbohydrates and carotenoids were tested by usual methods.

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