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Research Article

Study of Nutritional Contents of *Macadamia integrifolia* Maiden & Betche Leaves, Kernel and Pericarp Cultivated in Egypt

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ABSTRACT

Macadamia integrifolia Maiden & Betche (Proteaceae) is one of the major tree crops of the world. In addition to its nutritional value, macadamia also contains a number of phytochemicals that are responsible for a variety of bioactivities, among which hypocholesterolic activity which has been frequently studied. No previous studies were done on the Macadamia cultivated in Egypt, this encouraged the authors to perform the present study aiming to throw light on the nutritional profile of title plant.

Proximate analysis of the leaves, pericarp and kernel *Macadamia integrifolia* Maiden & Betche includes the determination of moisture content, total ash, total protein, total fats, total carbohydrates and crude fibers, study of vitamin E content by using HPLC, determination of the mineral content according to Association of Official Analytical Chemists(A.A.O.C). Macadamia showed a total fat (5.085%) in leaves, (67.96%) in kernel and (0.34%) in pericarp. The protein constitute (6.65 %) in leaves, (20.81%) in kernel and (6.91%) in pericarp. Carbohydrate constitutes (72.35%) in leaves, (5.8%) in kernel and (77.58%) in pericarp. Moisture content ranged from (11.72%) in leaves, (2.83%) in kernel and (9,65%) in pericarp. Ash content was (4.2%) in leaves, (2.6%) in kernel and (5.52%) in pericarp. The content of vitamin E in macadamia tested parts was (133.18 mg/100gm) in leaves, (61.49 mg/100gm) in kernel and (98.78 mg/100gm) in pericarp. The mineral contents of macadamia tested parts were resulted Calcium (851.51 mg/100gm) in leaves, (181.64 mg/100gm) in kernel and (177.16 mg/100gm) in pericarp, Potassium (838.16 mg/100g) in leaves, (3458.14 mg/100gm) in kernel and (7803.68 mg/100gm) in pericarp, Sodium constitutes (309.36 mg/100g) in leaves, (69.67 mg/100gm) in kernel and (156.58 mg/100gm) in pericarp, Iron was (9.72 mg/100g) in leaves, (9.48 mg/100gm) in kernel and (9.75 mg/100gm) in pericarp and Copper resulted (0.76 mg/100g) in leaves, (0.634 mg/100gm) in kernel and (0.668 mg/100gm) in pericarp.

Keywodrs: Proteaceae, nutritional, *Macadamia integrifolia*, Pericarp.

INTRODUCTION

Macadamia nut, also known as the Queensland nut, Australian nut, bopple nut, bauple nut, popple nut, kindal, boombera, burrawang[1] is the kernel obtained from the two species of *Macadamia integrifolia* and *M. tetraphylla* is a dark green spreading semi-hard wood and can grow up to 20 meters[2]. It belongs to family Proteaceae of which about 1000 species exist. The genus Macadamia consists of nine species; *Macadamia integrifolia*, *Macadamia tetraphylla*, *Macadamia ternifolia*, *Macadamia jansenii*, *Macadamia whelani*, *Macadamia claudiensis* and *Macadamia grandis* which are native to Australia, *Macadamia neurophylla* which is native to New Caledonia and *Macadamia hildebrandii* which is native to Sulawesi in Indonesia[3,4]. However, only the smooth-shelled *Macadamia integrifolia* Maiden & Betche, and the rough shelled *Macadamia tetraphylla* L.A.S. Johnson are cultivated for their edible nuts[5,6]. The Macadamia kernel is the edible part of Macadamia[7,8]. It can be eaten raw or fried, or roasted and salted. It is also used for dessert and snacks[9] and as an ingredient in various confectioneries such as biscuits, ice cream and chocolates[7,8,10]. Oil is also extracted from the kernek and used for salads[11,9]. *Macadamia integrifolia* oil is similar in composition to olive oil and is made up of 58.2% monounsaturated fatty acids and is therefore considered as a healthy food product as it contains no cholesterol[12,13]. The oil also improves the balance between omega 6 and omega 3 fatty acids, thus facilitates blood circulation through the coronary arteries[14]. Macadamia oil is also used in the manufacture of cosmetics[12]. With the selection of superior varieties and development of vegetative propagation techniques and other agronomic packages, Macadamia continued to gain economic importance[15].

MATERIAL AND MTHODS

Determination of macronutrients

Proximate analysis of the leaves, kernel and pericarp of *Macadamia integrifolia* Maiden & Betche includes the determination of moisture content, total ash, total protein, total fats, total carbohydrates and crude fibers. This analysis was done in accordance with the following references:

Nutritive value: was determined by multiplying the

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Table 1: The proximate analysis of the leaves, kernel and pericarp of Macadamia integrifolia Maiden & Betche.

Item	Percentage		
	Leaves	Kernels	Pericarp
Moisture content	11.716	2.83	9.65
Total ash	4.196	2.604	5.52
Total protein	6.651	20.805	6.909
Total fat	5.085	67.96	0.34
Total carbohydrates*	72.352	5.801	77.581
Crude fibers	17	19.42	28.93
Nutritive value	361.78 Kcal/100 g	718.24 Kcal/100 g	341.02 Kcal/100 g

*calculated by difference

values obtained for protein, fat and carbohydrate by 4.00, 9.00 and 4.00 respectively and adding up the values[17].

Moisture content: was determined by drying about 2 grams of the leaves, kernels and pericarp at 105°C until particularly constant weight was obtained. This required about 16 hours in an oven at 105°C[18].

Total ash: 2 grams of the leaves, kernels and pericarp accurately weight, were heated in a crucible at 100ºC until water was expelled. The residue was heated slowly over a flame until swelling ceased. The crucible was then left in a muffle furnace at about 505ºC to a constant weight[18].

Total carbohydrates

Determination of Total Hydrolysable Carbohydrate

A known weight (0.2-0.5g) of the dried ground leaves, kernels and pericarp were placed in a test tube, and then 10 mls of 1N sulfuric acid was added. The solution was then filtered into measuring flask (100 ml) and completed to 100 mls with distilled water.

The total Hydrolysable Carbohydrate were determined with the phenol-sulphuric acid method according to[19]

Determination of Total Soluble Sugars

Dried ground leaves, kernels and pericarp (0.5) g were accurately weighed and extracted by boiling in 80% neutral aqueous ethanol for 6 hours. The extract was filtered, then the ethanol was removed by vacuum distillation, then the residue was completed to 50 ml with distilled water in a measuring flask. Total soluble sugars were determined in the extract using the phenol-sulphuric acid method according to[19] as follows: to 1 ml of aqueous sugars extract, 1 ml of 5% phenol solution was added and mixed. Then, 5 ml of sulphuric acid (98%) was added from a vast delivering pipette. The blank experiment was carried out by using distilled water instead of sugar solution. The tubes were shaken and allowed to stand for 10 mins. The absorbance of yellow orange colour was measured at 490 nm. A stand curve was carried out by using pure glucose.

Total fats

The method of A.A.O.C. (1995)[18] was conducted for lipid extraction from from the leaves, kernels and pericarp using chloroform: methanol (2:1 v/v) to extract the lipids. The associated non-lipids were removed by washing lipid extract three times with methanol:water (1:1 v/v). The lipids in chloroform were dried over anhydrous sodium sulphate and then the solvent was removed by heating at 80ºC under vacuum.

Total proteins

The total protein content of the samples was determined by Kjeldahl method according to[18], the samples were heated with sulphuric acid, which decomposes the organic substance by oxidation to liberate the reduced nitrogen as ammonium sulfate. The solution is then distilled with sodium hydroxide, which converts the ammonium salt to ammonia. The amount of ammonia present, and thus the amount of nitrogen present in the sample, is determined by back titration. The end of the condenser is dipped into a solution of boric acid. The ammonia reacts with the acid and the remainder of the acid then titrated with a sodium carbonate solution using methyl orange as a ph indicator.

Study of vitamin E content

Vitamin E content of the leaves, kernels and pericarp of *Macadamia integrifolia* Maiden & Betche was determined by HPLC according to the method described by[20].

A Hewlett-Packard Series 1,100 liquid chromatography system (Waldbronn, Germany) equipped with a loop (20µl) diode array detector and a lichrosorb RP 15 column (4.0 mm i.d.x 250 mm; particle size 5 mm) (Merck, Darmstadt) was used. Elution was performed at a flow rate of 1 ml / min with mobile phase of water / acetic acid (98: 2 v/v, solvent A) and methanol / acetonitrile (50: 50, v/v, solvent B), starting with 5 % B and increasing B to levels of 30% at 25 min, 40% at 35 min, 52% at 40 min, 70% at 50 min, 100% at 55 min, and kept at this stage for 5 min. A re-equilibration time of 15 min was then required. Quantitation was achieved at 292 nm by internal standard method[21]. Vitamin E content was determined according to the method described by[22]

Determination of the mineral content

The mineral content was determined according to[18]. Samples were digested by wet digestion with concentrated sulfuric acid in the presence of digestion catalysts (a mixture of copper sulfate and anhydrous sodium sulfate, (1:10), then the resulted solution was measured using Atomic Absorption Spectrometer.

RESULTS

Results are illustrated in the tables (1-3)

DISCUSSION

Although calorie-rich, tree nuts are a good source of several nutrients including proteins, certain vitamins and minerals, and several bioactive components such as sterols. The high calories in tree nuts are mainly due to their high lipid content[23]. Macadamia nuts (the kernel) showing a total fat (67.96%) which indicating it is a good oil source. also the protein constitute (20.805 %), showing that Macadamia is nutritiously and suggest that it can contribute to the daily protein need for adults as recommended by the Dietary Reference Intakes. While Macadamia kernels show lower amount of carbohydrate (5.801%) than leaves and pericarp, which contain (72.352%) and (77.581%) respectively.

Macadamia kernel shows a low moisture content (2.83%) which is important for an extended shelf life and sensory

Table 2: Vitamin E content of the leaves, kernel and pericarp of Macadamia integrifolia Maiden & Betche.

Item	Recommended dietary allowance	Content (mg/100gm)		
		Leaves	Kernels	Pericarp
Vit. E	15 mg	133.18	61.489	98.782

Table 3: Mineral content of the leaves, kernels and pericarp of Macadamia integrifolia Maiden & Betche.

Mineral	Essentiality	Amount mg/100g		
		Leaves	Kernel	Pericarp
Potassium	Quantity elements	838.16	3458.41	7803.68
Calcium		851.51	181.64	177.16
Sodium		309.36	69.07	156.58
Iron	Essential trace elements	9.72	9.48	9.75
Copper		0.76	0.634	0.668

quality of nuts, as low moisture helps reduce microbial growth and various undesirable biochemical changes that often accompany it and the ash content which is relatively low (2.604 %).

These results, thus give an indication that Macadamia nut kernels are rich source of energy (718.244 Kcal /100 g) and are capable of supplying the daily energy requirements of the body. The content of vitamin E in Macadamia integrifolia leaves, kernels and pericarp analyzed (133.18, 61.49 and 98.78 mg/100gm respectively) comes in higher content than those listed in USDA National Nutrient Database for Standard Reference, 26mg/100g, as leaves contain the highest content followed by pericarp and kernel comes at last with the least vitamin E content among the tested parts. Vitamin E is well accepted as nature's most effective lipid-soluble, chain-breaking antioxidant, protecting cell membranes from peroxidative damage. Free-radical-mediated pathology has been implicated in the development over time of degenerative diseases and conditions[24]. The macronutrients (quantity essential elements) such as sodium, potassium and calcium are present in *Macadamia integrifolia* Maiden & Betche leaves, kernels and pericarp in considerable amounts, where the concentration of sodium is the highest in Macadamia leaves (309.36mg/100g), and the kernels contain the lowest amount (69.067 mg/100g) which is considered beneficial as although, sodium is a part of everyone's diet, but sodium intake is one factor involved in the development of hypertension.

On the other hand, foods rich in calcium and potassium are strongly recommended as protective measures against hypertension as recommended by the American Heart Association[25]. Calcium, the most abundant mineral in the body, is an important component of a healthy diet and a mineral necessary for life. Calcium is required for vascular contraction and vasodilation, muscle function, nerve transmission, intracellular signaling and hormonal secretion. Long-term calcium deficiency can lead to rickets and poor blood clotting and in case of a menopausal woman; it can lead to osteoporosis[26]. Therefore, *Macadamia integrifolia* Maiden & Betche leaves, kernels and pericarp (containing 851.5, 181.64 and 177.16mg/100g respectively) would count in the recommended daily intake of calcium, where the leaves of Macadamia showed the highest source of Calcium among the tested parts. Potassium plays an important role in muscle contraction and nerve transmission as when the movement of potassium is blocked, or when potassium is deficient in the diet, activity of both muscles and nerves can become compromised. Also, potassium is involved in the storage of carbohydrates for use by muscles as fuel. It is also important in maintaining the body's proper electrolyte and acid-base (PH) balance[27]. Potassium may also counteract the increased urinary calcium loss caused by the high-salt diets[28]. *Macadamia integrifolia* Maiden & Betche pericarp is considered as a good source of potassium (7803.68mg/kg), followed by kernel (3458.4 mg/kg), whereas leaves contain the lowes concentration of Potassium (838.16 mg/kg). With regard to minerals, the nutritional interest of Macadamia is mainly due to trace elements such as Iron and Copper. Generally, the tested parts of *Macadamia integrifolia* Maiden & Betche were found to contain Iron more than Copper. These elements are essential micronutrients for human health. In addition, they play an important role in human metabolism, and interest in these elements is increasing together with reports of relationships between trace elements status and oxidative diseases[29].

Copper content of *Macadamia integrifolia* Maiden & Betche is close in the tested parts of the plant (0.76 mg/100g in leaves, 0.668 mg/100g in pericarp and 0.634 mg/100g in kernel) and is close to RDA. This element is essential as it can be found in many enzymes, including those involved in energy production, connective tissue formation, central nervous system function, antioxidant functions, melanin formation, gene expression and iron metabolism.

CONCLUSION

It is note-worthy to mention that these data could be useful criteria for the identification of *Macadamia integrifolia* Maiden & Betche cultivated in Egypt. This is the first report on the nutritional profile of its leaves, kernels and pericarp. The data reported in this work confirms that the kernels of *Macadamia integrifolia* Maiden & Betche cultivated in Egypt are good and healthy food and should readily be incorporated into the diet also the pericarp and leaves of the plant are nutritionally valuable for waste parts of the plant.

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