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EVALUATION OF FATTY ACID, MINERAL AND VITAMIN COMPOSITIONS OF *LAURENCIA PAPILLOSA* FROM THE SOUTH EAST COAST OF INDIA

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Abstract:

The objective of the present study is to evaluate the fatty acid, mineral and vitamin compositions of a marine red alga Laurencia papillosa collected from the South East Coast of India in order to assess its nutritional quality to use it as animal feed. Crude lipid was extracted and the fatty acid compositions were evaluated by Gas chromatography. Ash content was estimated by incinerating the alga in muffle furnace and the mineral compositions were evaluated using atomic absorption spectrophotometer. Vitamin compositions were evaluated using the HPLC system. The outcomes demonstrate that Laurencia papillosa contained nine fatty acids ranged from 0.18 ± 0.04 to 9.51 ± 0.19 (mg/g DW). Unsaturated fatty acid contained around 45% and saturated fatty acids constituted 55% of the total fatty acids. Among unsaturated fatty acid, the level of PUFAs was observed to be 39.25%. Macro mineral contents were in the order of Na> Mg> C> K and trace elements were in the order of Zn> Fe> Cu. Further, Laurencia papillosa contained seven vitamins, of which vitamin-C was observed to be higher in content. The potential nutritional values of Laurencia papillosa were found in the present evaluation confirm its sustenance value for animals including humans in terms of nutrients.

Key words: *Fatty acids, Vitamins, Minerals, Marine red alga, Laurencia papillosa.*

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INTRODUCTION:

Regularly expanding world populace and ever increasing consciousness of healthy foods without or less side effects among consumers has set off the attention for the hunt of new sustenance supplements globally. In numerous developed countries, other than nourishment supplements, eating of interesting new foods with significant nutritional values has also been gaining importance [1]. The presence of some essential nutrients, for example, minerals, fatty acids and vitamins in foods make them nutritionally high and beneficial, which are either absent or present only in trace concentrations in the usual conventional foods [2]. Along these lines, researchers have an interest in the investigation and usage of natural foods from nonconventional sources to upgrade the dietary estimation of human sustenance's and one such food is seaweeds from marine source.

Seaweeds are group of large and complex marine benthic algae that are macroscopic in nature. The use of seaweeds has a long history from time immemorial. Seaweeds contain a noteworthy amount of protein, fats, polysaccharides and amino acids of high dietary significance and additionally physiologically imperative unsaturated fats, miniaturized scale and large scale components and vitamins [3- 6]. Seaweeds have bioactive compounds with antiviral, antibacterial or antitumor activities [7-10]. Seaweeds usually contain low lipid contents, yet contain a good ratio of essential fatty acids like polyunsaturated fatty acids (PUFAs) mainly omega-3 fatty acids. PUFAs are the essential components of all cell membranes and antecedents of eicosanoids that are vital bioregulators of several cellular processes [11]. PUFAs successfully reduce the risk of osteoporosis, diabetes, cardiovascular diseases and cancer [12]. Today, marine fish are the most important sources of PUFAs, but for vegetarians? The seaweeds can be a good alteration for marine fishes.

Marine algae accumulate minerals and trace elements from sea water which are in an organic form [13]. Seaweeds generally contain rich mineral content which can fulfill the recommended daily intakes of essential macro and trace elements for human nutrition [5, 10, 12, 14, 15]. Minerals as cofactors of enzymes have very imperative in human biochemical responses and its deficiency can lead to serious health problem. Minerals also play an essential role in living a healthy life. Seaweed mineral content is higher than that of terrestrial plants [14, 16, 17].

Seaweeds also reported to be incredible sources of water soluble vitamins such as B1, B2, B12 and C and fat soluble vitamins such as beta-carotene with vitamin A and vitamin E [18]. Seaweed vitamins play an imperative part in biochemical functions and antioxidant activity [19]. Seaweeds are often referred as "sea vegetables" due to the significance of its dietary value. It has been accounted that the consumption of seaweeds regularly as part of diet has reduced risk for various diseases [20]. Nowadays, the consumption of seaweeds has been radically expanded around the world [21].

Laurencia papillosa (C.Agardh) Greville is a marine red alga belongs to the family of Rhodomelaceae under the class of Florideophyceae and order Ceramiales. This marine species is found almost in all the oceans expect Arctic and Antarctic Ocean regions [22]. In India it is found in all the Intertidal and subtidal zones of the ocean and this species is economically important as a source of food and agaroid [23], but very limited reports on the nutritional potentials of *L. papillosa* of the Indian coast has been made. Hence, the objective of the present study was to assess the nutritional potentials in terms of fatty acids, minerals and vitamins of the edible red seaweed *L. papillosa* from the South East coast of India.

MATERIALS AND METHODS:

Sample Collection

Laurencia papillosa (C.Agardh) Greville, red alga, was collected from Mandapam coastal regions, the South East coast of Tamilnadu, India. The seaweed sample was collected from intertidal zones and washed with sea water in order to remove the foreign particles such as sand particles and epiphytes. Then the seaweed samples collected were taken to laboratory of Algal Biotechnology and Bionano Technology, Pachaiyappa's College, Chennai-30. The morphological characters of the alga were confirmed with the monograph of Rhodophyceae [24]. The voucher specimens (PCCACL12) were stored at the Herbarium in Department of Botany, Pachaiyappa's College, Chennai – 600 030. Seaweeds were shade dried and were powdered using a blender. The pulverized powder was stored in sterile bottles in the dark for further use.

Crude lipid extraction

Crude lipid was extracted after following the method of Folch et al., [25]. A known amount of the experimental seaweed sample was homogenized using a mortar and pestle and extracted three times with 14 mL of chloroform: methanol mixture (2:1). Homogenized extract was transferred to a separating funnel for dividing to which NaCl (5%) was added to

the aqueous phase in order to help the separation and allowed to stand overnight in the dark. The organic phase was collected and evaporated to dryness in vacuo and the total lipid content was determined gravimetrically.

Fatty acid analysis

The fatty acid composition was determined by the method described by Miller and Berger [26] using the NEON II gas chromatography instrument with FID detector and DEGS 10% capillary column, 180º, 200º and 210º C used for oven temperature, infusion port temperature and detector temperature, separately. Nitrogen was used as a carrier gas and Fatty acid methyl ester (FAME) was prepared according to AENOR [27]. FAME reference obtained from Merck was used for identification.

Mineral analysis

Ash content of the alga was estimated by incineration of 1 g dried sample in a muffle furnace at 550°C [28]. The macro mineral content was evaluated by the method portrayed by El Din and El-Sherif [29]. The trace elements were evaluated by the technique portrayed by Topcuoglu *et al.*, [30]. The mineral content of experimental alga was analyzed by dissolving in HNO_3 using atomic absorption spectrophotometer (Perkin–Elmer model 303). Triplicate determinations for every element were carried out. The concentration of the elements was estimated from calibration curves of the standard elements.

Vitamin analysis

Vitamins in the experimental alga were measured using an AGILENT 1100 chromatography system by following the technique of AOAC [31]. The whole chromatographic system was controlled by the chemstation software.

Statistical analysis

All data are expressed as a mean standard deviation (n = 3). Statistical comparisons of the results were performed using SPSS ver.19 by one-way analysis of variance (ANOVA) using Microsoft Office Excel 2007 (Microsoft, USA) followed by Dunnet's t test to determine the statistical significance. A significant difference was considered at the level of $p<0.05$ and $P< 0.01$.

RESULTS AND DISCUSSION:

Fatty acid compositions

Table.1 represents the estimation of fatty acid compositions of experimental alga in mg/g DW and also in the percentage mean value as well. The fatty acid composition of experimental alga was 55% saturated fatty acids (SFAs), 14.28% monounsaturated fatty acids (MUFAs) and 30.72% polyunsaturated fatty acids (PUFAs). Among every fatty acids, the proportion of margaric acid (C17:0, 0.78%) and stearic acid (C18:0, 40.89%) was observed to be lowest and highest, respectively. Oleic acid was the only monounsaturated fatty acid content in the algal sample. SFA levels in this macro alga were higher than those found by Johns *et al*., [32] in green (23.9%), brown (27.9%) and red (33.8%) macro algae. However, the level of MUFAs was 14.28% were lower than those observed in other species, while PUFA levels were 30.72% were higher to those found by Mehdipour [33]. The seaweed examined contained C18:0 (Stearic acid) and the essential fatty acid C18:2 (linolenic acid) as the major saturated and polyunsaturated fatty acids, individually. The fatty acid profile displayed a predominance of the two classes, SFAs and PUFAs (Table.1), while the proportion of the MUFAs was lower. The noteworthy amount of n3 PUFAs was found (21.86%) in our results. An ideal ratio of n6/n3 of 4.0 at maximum was recommended by the UK Department of Health [34]. Values exceeding the maximum value are harmful to health and may cause cardiovascular diseases [35]. In our examination, the ratio of n6/n3 was good and PUFA/SFA ratio was 2.46 ± 0.00 which is higher than the minimum recommended value of the PUFA/SFA ratio is 0.45 [34]. Consequently the experimental alga is nutritional with good amount of fatty acids which is also edible.

Table.1: Fatty acid compositions of *Laurencia papillosa.**

Fatty acid	Carbon	mg/g DW	Composition (%)
Saturated fatty acids			
Palmitic acid	16:0	3.10 ± 0.17^{e}	13.33
Stearic acid	18:0	9.51 ± 0.19^{g}	40.89
Margaric acid	17:0	0.18 ± 0.04 ^{a}	0.78
Monounsaturated fatty acids			
Oleic acid	18:1	3.32 ± 0.24^{e}	14.28
Polyunsaturated fatty acids			
Linolenic acid	18:2(ω6)	2.06 ± 0.04^{cd}	8.86
Alpha linolenic acid	18:3(ω3)	1.87 ± 0.26^{cd}	8.04
Moroctic acid	18:4(ω3)	0.56 ± 0.18 ^{ab}	2.4
Eicosapentaenoic acid (EPA)	20:5(ω3)	1.47 ± 0.01^{cd}	6.31
Docosahexaenoic acid (DHA)	22:6(ω3)	1.19 ± 0.01^{abc}	5.11
Total SFAs		12.80 ± 0.40^{h}	55.00
Total MUFAs		3.32 ± 0.24^{e}	14.28
Total PUFAs		7.15 ± 0.01^{f}	30.72
Total Fatty acids		22.90 ± 0.19^{i}	100.00
Ratio ω3/ω6 (mg/g)		2.4643 ± 0.00^{de}	2.46 ± 0.00
Total lipid content		24. ± 0.19^{i}	

*****Values are expressed as Mean ± SEM, n=3; Means in each column with different superscripts letters are significantly different at $p<0.05$, while others at $p<0.01$.

Mineral compositions

Table.2 demonstrates the composition of ash and minerals in the experimental seaweed. Seven elements, Na, Mg, Ca, K, Zn, Fe and Cu, were found in the experimental alga of which four macro elements and three trace elements were recorded, with values extending from 0.42 ± 0.11 – 30.73 ± 0.66 mg/g DW. Na was the most plentiful (30.73 ± 0.66 mg/g DW) and Cu was least (0. 42 ± 0.11 mg/g DW) among minerals investigated. Na and K are power minerals, Na/K proportion is a measure of the electrical potential of the cells. Dr. Eck found that the ideal hair Na/K ratio is around 2.5 and a good range is between around 2.50 and up to around 4 in a human being [36]. In our examination, Na/K ratio observed to be 2.48 ± 0.00 mg/g DW. In the present study trace-elements (i.e., Fe, Zn and Cu) were also observed. Among the trace-elements analyzed, Zn was highest 1.79 ± 0.24 mg/g DW. Minerals occur in organic form which cannot be synthesized by the human body and can be only taken food nourishment which gets consumed by the body. It plays vital role in several body functions and its deficiency is highly associated with blood sugar imbalance, diabetes, most frequent causes of hypertension appears and furthermore connected with the causes of cancer and cardiovascular disease such as heart attacks and strokes [37]. A few investigations have demonstrated that the alkalinity of seaweed confers numerous health benefits, such as improving thyroid function and lowering the acidity levels in the body, subsequently preventing the development of degenerative illnesses such as cancer and heart disease [12]. Since our experimental alga contained all essential minerals in good amount, this edible marine seaweed may be a potential diet source of minerals because these trace elements are either absent or only very lesser in land vegetables [17, 38, 39].

Table. 2: Ash and Mineral compositions of *Laurencia papillosa**

Composition	mg/g DW
Ash content	193.43 ± 0.37^{h}
Macro minerals	
Na	30.73 ± 0.66^{f}
Mg	23.17 ± 0.15^{e}
Ca	20.43 ± 0.26^{d}
K	12.39 ± 0.28^{c}
(Na+K+Ca+Mg)	87.39 ± 1.22
Na/K	2.48 ± 0.00^{b}
Trace minerals	
Zn	1.79 ± 0.24^{ab}
Fe	1.75 ± 0.16^{ab}
Cu	0.42 ± 0.11^{a}

*****Values are expressed as Mean ± SEM, n=3; Means in each column with different superscripts letters are significantly different at p<0.05, while others at p<0.01.

Vitamin compositions

Vitamins are one of the four most vital groups of essential nutrients alongside minerals, essential fatty acids and essential amino acids. Investigation of the vitamin contents of the experimental alga was done and vitamins B1, B2, B3, B5, B6, B12 and Vitamin C were recorded (Table.3). From the Table (3) it can be noticed that the most and least vitamin available in the *L. papillosa* was vitamin C (1.328 ± 0.20 mg/g DW) and B6 (0.0007 ± 0.00 mg/g DW), respectively. Due of the presence of significant content of various vitamins specially vitamin C, the experimental alga *L. papillosa* can reduce the risk of chronic diseases such as obesity, heart disease, diabetes, cancer, blood pressure and so on and may be a potential source of antioxidant activity because of its notable vitamin C content [19, 40]. According to the above outcomes, the experimental alga *L. papillosa* show potential nutritional properties along these lines it can be an alternate source of vitamin supplements for animals including human beings.

Table.3. Vitamin compositions of *Laurencia papillosa**

Vitamin	mg/g DW
Vitamin B1	0.026 ± 0.00^{a}
Vitamin B2	0.043 ± 0.44^{a}
Vitamin B3	0.059 ± 0.00^{a}
Vitamin B5	0.051 ± 0.00^{a}
Vitamin B6	0.094 ± 0.00^{a}
Vitamin B12	0.0007 ± 0.00^{a}
Vitamin C	1.328 ± 0.20^{b}

*****Values are expressed as Mean ± SEM, n=3; Means in each column with different superscripts letters are significantly different at p<0.05, while others at p<0.01.

CONCLUSION:

Laurencia papillosa can be considered as an under-exploited source of health promoting molecules which can be used as food and nutraceutical agent. It is rich in some omega-3 fatty acids, macro and trace minerals and vitamins. Henceforth, *L. papillosa* can be an excellent source of some essential nutrients such as fatty acids, minerals and vitamins and because of its high nutritional value; it might be an awesome potential healthy food.

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