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Effect of processing techniques (Pretreatments and Drying) on physico-chemical profile of drumstick leaves powder

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Abstract
The effect of pretreatments and drying methods on the nutritional and physicochemical composition of drumstick leaves powder was studied. Part of the harvested leaves was subjected to steam blanching, chemical blanching and part unblanched, and subjected to shade and cabinet drying. Results revealed that among drying methods, cabinet drying at 60 °C for 6hrs resulted in the best nutritional and physicochemical properties of the Moringa leaf powder. Blanching and chemical treatment had variable effects on processed leaves with significant (p<0.05) reductions in moisture, yield and a significant increase in water soluble extract and pH. The protein, light petroleum extract and ash content was increased significantly and carbohydrate, crude fiber was increased insignificantly due to cabinet drying and chemical blanching. The acid insoluble ash, Mg, Zn, Cu was significantly (p<0.05) retained in unbalanced leaves in both drying methods except Ca content, while Fe and Mn which was increased in chemically blanched leaves.

Keywords: drumstick leaves powder, drying, pretreatment, proximate analysis and mineral composition

Introduction

Moringa leaves are edible and are of high nutritive value. It is consumed throughout West Africa as well as some Asian countries [1]. Moringa leaves contain more vitamin A than carrots, more calcium than milk, more iron than spinach, more vitamin C than oranges, and more potassium than bananas, noting that the protein quality of Moringa leaves rivals that of milk and eggs. Moreover, total protein digestibility of these leaves is high (85 % to 90 %) and its amino-acid composition corroborates with the FAO reference protein for growing child. The leaves are also free of antinutritive factors such as phenols, tannins and saponins [2].
At present, the nutritional value of Moringa are well known that there seems to be little doubt of the substantial health benefit to be realized by consumption of Moringa leaves powder in situations where starvation is imminent. Nonetheless, the outcomes of well controlled and well documented clinical studies are still of great value [3]. In developing countries Moringa leaves are rarely processed. A relatively small quantity of harvested Moringa leaves are however, sun- or shade-dried resulting in products with variable moisture contents thus affecting storage stability [4, 5]. Additionally, reports have proven that sun-dried vegetables have inferior colour, texture and acceptability compared with vegetables dried in the cabinet drier [6]. For Moringa leaves with very high moisture contents, dehydration results in considerable reduction in weight and bulk and consequent savings in storage and distribution costs. Also, unit operations that intentionally separate the component of foods alter the nutritional qualities of each fraction compared with the raw material [7]. Reported that blanching which is an important pre-processing heat treatment of vegetable destined for freezing, canning or dehydration inevitably causes separation and loss of water soluble nutrients such as minerals, water soluble vitamins and sugars. According to [7], blanching at 88ºC stops all life processes, inactivates enzymes, fixes green colour and removes certain harsh flavours common in vegetables. Thus it is evident that different methods of processing could have an effect on the quality of Moringa leaves based product. The aim of the present investigation is to evaluate the physiochemical properties of drumstick leaves powder prepared by using different indigenous processing techniques.

2. Materials and methods

2.1 Preparation of drumstick leaves powder

The research was carried out using fresh drumstick (*Moringa olifera*) leaves cultivar variety Coimbatore which were procured and processed within 2 hrs after procurement. The *Moringa olifera* tops (about 15 cm in length from the tip of the plant) leaflets obtained after harvesting were sorted to eliminate damaged ones and washed. The leaves were given different pretreatment viz. unblanching, blanching (steam for 5 min), and chemical blanching containing 0.5% potassium metabisulphite (KMS),0.15% Magnesium Oxide(MgO),0.15% Sodium Carbonate(Na_2Co_3) was prepared in the ratio of 1:3 of leaves: chemical solution at 80ºc for 1-2 min. The excess of water was drained and pretreated leaves were dried by using two drying methods viz. shade drying (SD) and cabinet drying (CD).In the shade drying, pretreated and untreated leaves were spread in stainless steel trays for shade drying and includes conditions like drying at room temperature (28-30 ^{0}C) for 6 days. In cabinet drying unblanched, blanched and chemically blanched leaves were dried at 60 ^{0}C for 6 hrs in cabinet drier. The leaves were allowed to dry until constant weight and further milled to get drumstick leaves powder (DLP) having mesh size 150µm and packaged into polypropylene films to avoid moisture absorption.

2.2 Physico-chemical analysis
The physical properties viz. moisture content, pH, was determined by using [8] while water soluble extractives was determined by procedure given by [9] and weight of dried leaves was quantified in percent yield.

2.3 Chemical analysis
The prepared leaves powders were analyzed for their proximate contents using the [8] method. The moisture content was determined by air-oven drying at 130ºC for 1 hr, and the crude protein contents by micro Kjeldal method (% protein = N x 6.25). The lipid content was determined using petroleum ether (bp. 60-80ºC) in a soxhlet extraction apparatus and crude fiber content by dilute acid and alkali hydrolysis. Five (5) grams of dried powder sample was dissolved in 6 M HCl solution and the resulting solution was made up to a definite volume (20ml) and used for the determination of minerals viz., copper, manganese, iron and zinc were determined by Atomic absorption spectrophotometer (AAS200 -Perkin Elmer) while calcium and magnesium was determined by using method given by [10].

2.4 Statistical analysis
The analysis of variance of the data obtained was done by using Completely Randomized Design (CRD) for different treatments as per the methods given by [11]. The analysis of variance revealed at significance of $P < 0.05$ level, S.E. and C.D. at 5 % level is mentioned wherever required.

3 Results and discussion
3.1 Physical Properties of Drumstick Leaf Powder

Table 1: Effect of Processing on Physical Properties of Drumstick Leaves Powder

Samples	Moisture Content	pH	Water Soluble Extractives	Per-cent Yield
SD-UB	12.5	5.66	7.85	25
SD-B	9.6	6.2	8.5	19.6
SD-CT	10.3	6.087	8.6	21
CD-UB	10.5	5.33	7.95	23
CD-B	7.5	5.517	8.2	18
CD-CT	9	5.441	8.4	20
SE±	0.364	0.0267	0.0521	0.552
CD at 5%	1.123	0.0822	0.1604	1.699

SD-UB= Shade dried Unblanched SD-B= Shade dried blanched SD-CT=Shade dried chemical Treatment CD-UB = Cabinet dried Unblanched CD B=Cabinet dried blanched CD-CT=Cabinet dried chemical Treatment

The drying of drumstick leaves reduces the moisture content. The lowest moisture content was observed in cabinet dried blanched sample (7.5%) while highest moisture content was observed in shade dried unblanched sample of (12.5%) which may reduce the shelf life of prepared powder. Moreover, the blanched and chemical treated leaves powder were having low moisture content than unblanched sample in both drying methods. Blanching treatment in both the drying method was found to be significantly superior over blanching with chemical treatment and unblanched samples. However there was slight difference in moisture content was observed in between blanching and blanching with chemical treatment in both drying method i.e shade and cabinet drying. This result are consistent with the findings of [12, 13] who showed that cells loose their wall integrity when blanched with steam and thus bound water is lost faster than in un-blanched samples.

The pH value for the shade dried sample ranged from 5.66 to 6.2 while in case of cabinet dried samples it was Between 5.33 to 5.5 which indicate slightly acidic nature of leaves. However, there was significant difference in pH values between chemical treatment, blanching and un-blanched leaves. Moreover the unblanched leaves are more acidic in both drying method and pretreatment reduces the acidity of leaves.

The water soluble extractives of DLP for both drying methods found in unblanched samples was least when compare to blanched and blanched with chemical treatment. Blanched and blanched with chemical treatment was found to statistically at par with each other in shade drying.

The per-cent yield of prepared DLP depends upon drying methods, influence of pretreatment and moisture content. The highest yield was obtained in shade dried unblanched (25 Per-cent) while lowest is obtained in case of cabinet dried blanched DLP. Moreover cabinet dried sample having less yield then shade dried sample. The reduction of per-cent yield in treatment of blanching may be due to split up of tissues in the leaves during blanching which causes rapid evaporation of water as compare to unblanched sample in both drying.

3.2 Proximate composition of Drumstick Leaves Powder
The proximate composition of the DLP was estimated and their mean values are depicted in Table 2.

Table 2: Effect of Processing Techniques on Proximate Composition of Drumstick Leaves Powder

Samples	Carbohydrates (%)	Protein (%)	Light Petroleum Extract (%)	Crude Fiber (%)	Ash (%)
SD-UB	38.49	24.94	4.8	10.8	8.47
SD-B	41.93	25.07	4.96	9.2	8.6
SD-CT	39.54	26.9	5.6	9.5	8.8
CD-UB	39.12	26.88	4.9	9.6	9
CD-B	41.38	27.74	5.2	9.67	7.6
CD-CT	37.98	28.65	5.68	10	9.6
SE±	1.328	0.576	0.1763	0.528	0.349
CD at 5%	NS	1.746	0.5426	NS	1.075

The carbohydrates content in the SD-B sample of 41.93% followed by CD-B 41.38%. The lowest value was observed for CD-CT sample. There was no significant effect of processing on carbohydrate content of DLP. Among all the samples pretreatment of blanching increased carbohydrates content of DLP due to high dry matter.

The protein content of DLP was varied in between 24.94% to 28.65% in SD-UB and CD-B respectively. Among the pretreatments, chemically blanched samples were having more protein content, is followed by blanched and lowest protein content was observed in unblanched samples. Moreover cabinet dried samples were having more protein than that of shade dried samples. [12, 13] showed that loss of the cell wall integrity of blanched samples leads to a high mean moisture loss when they are panellisted to drying.

Light petroleum extracts (LPE) contents were particularly high in cabinet-dried leaves than shade-dried leaves. The highest value was 5.68 percent for CD-CT and the lowest value was 4.8 percent for shade-dried un-blanched leaves. Statistically blanching and blanching with chemical treatment were at par with each other. Leaves dried in cabinet driers yielded higher values than shade-dried samples, may be due to the extent of reduction in moisture contents in cabinet-dried leaves resulting in corresponding increases in dry matter contents due to concentration of solids.

Fiber in all processed leaves ranged from 9.2 % to 10.8 %. The lowest fiber content was observed in shade dried leaves with blanched and highest in shade dried unblanched leaves, no significant differences in the fiber contents of cabinet dried leaves compared with shade-dried samples. The content of fiber found in these processed drumstick leaves is an indicative that they are substantial and will provide bulk for peristaltic action, which enhances the movement of food through the alimentary canal with the potential to prevent colon cancer [14].

Generally, blanched dried leaves had lower ash content than un-blanched dried leaves in all the drying methods. This observation supports reports by [7] that blanching is an important pre-processing heat-treatment of vegetable destined for dehydration inevitably causes separation and losses of water soluble nutrients such as vitamins and minerals. Crude ash contents differed significantly between blanched and un-blanched leaves at 5 % level.

3.3 Mineral Analysis of Drumstick Leaves Powder

The processed DLP samples were analyzed for macronutrients like calcium, magnesium, and the micronutrients like manganese, iron, copper and zinc. The results were expressed for the macronutrients as g of element per 100 g on a dry weight bases (% g DW) and the micronutrients, mg of element per 100g on a dry weight basis mg element/100 g DW (Table 3).

Table 3: Effect of Processing Techniques on Mineral content of DLP

Samples	Acid Insoluble Ash	Ca	Mg	Fe	Zn	Cu	Mn
	gm/100gm				mg/100gm		
SD-UB	0.44	2	0.532	12.44	2.279	0.664	7.15
SD-B	0.41	1.44	0.263	10.52	2.264	0.654	6.165
SD-CT	0.48	1.88	0.497	15.53	2.26	0.642	8.165
CD-UB	0.42	1.2	0.693	13.12	2.385	0.69	7.37
CD-B	0.5	1.32	0.119	10.65	2.216	0.568	8.21
CD-CT	0.62	1.68	0.176	14.418	2.188	0.587	10.57
SE±	0.0294	0.0290	0.0041	0.2028	0.02345	0.0032	0.111
CD at 5%	0.0905	NS	0.0129	0.6241	0.0721	0.0099	0.343

The acid insoluble ash was increased in the treatment of blanching with chemical treatment in both drying methods. SD-UB had highest calcium content (2%) followed by SD-CT (1.88%). Drying methods does not influence calcium content. Blanching with chemical treatment retains more calcium content against other treatments.

Magnesium (Mg) contributes to bone health and bone density and is essential in a wide range of metabolic reactions [15]. It is involved as a co-factor in at least 300 enzymatic steps, many of which are linked to energy metabolism; thus, optimum magnesium level is believed to be critical for proper maintenance of body weight and the prevention of syndromes related to cardiovascular disease. Magnesium content is varied between 0.119% to 0.693% for CD-B and CB-UB respectively. The process of shade drying had significant effect over cabinet drying while pretreatment of blanching with chemical treatment was significant over unblanching.

There were significant differences in Fe contents in cabinet-dried leaves against shade-dried leaves. However, Fe contents of chemically treated leaves showed higher statistical difference as compared with unblanched, blanched leaves in both drying method. In addition, Fe values for blanched leaves were slightly lower than those of the un-blanched leaves. Loss of Fe in blanched leaves is supported by findings of [16] stated that the extent of possible losses of minerals such as Fe is related to the solubility of the salts present in the product. Also, blanching using boiling water at normal atmospheric pressure accelerates Fe losses [17, 18]. Drumstick leaf powder with such high values of iron (ranging from 10.52mg/100mg to 15.53mg/100g) falls within the Recommended Daily Allowance of childrens.

Shade-dried leaves had higher Zn contents than cabinet-dried leaves. A multiple comparison among drying methods revealed that there are significant differences ($p < 0.05$) with highest of 2.385 mg/100g and lowest of 2.188 mg/100g for CD-UB and CD-CT respectively. A general trend observed that blanched leaves had lower Zn contents than their corresponding un-blanched leaves, which could be attributed to leaching of minerals during blanching. However, statistical analysis showed blanched and un-blanched leaves were at par with each other in shade drying indicating that blanching did not affect Zn content. Zn contents (ranging from 2.32 mg/100g to 9.68 mg/100g) in the treated drumstick leaves are sufficient and the drumstick leaves could ideally enhance improvement of diet deficient of Zn.

There is a direct correlation between the dietary Zn/Cu ratio and the incidence of cardiovascular disease [19]. The range of copper present in the DLP varied between 0.568 and 0.69 mg/100gm. Shade drying retained more copper content than cabinet drying but CD-UB has retained highest copper of 0.69 mg/100gm which is followed by SD-UB with 0.664 mg/100gm and lowest Cu observed in CD-B sample with 0.568 mg/L there was significant effect of processing on copper content of DLP.

The principal function of the manganese is the activation of numerous essential enzymes, such as the enzymes which are known to use the energy of ATP. The manganese content was low in SD-B sample (6.165 mg/100gm) which is followed by SD-CT (7.15 mg/100gm) and CD-UB (7.37 mg/100gm) while the highest value is observed in CD-CT sample (10.57 mg/100gm). There is significant difference two drying method except unblanching and also found that cabinet drying has retained more Mn content than shade drying method.

Conclusion

In all among the given pretreatments blanching with chemicals was found to be statistically significant in protein fat and ash content over unblanched sample in both drying methods. The reduction in moisture content during drying resulted into high dry matter which increased the values of proximate constituent.

The selected pretreatment and drying method, it was finally concluded that the unblanched samples retained higher Ca, Mg, Zn, and Cu in shade drying. It can be also seen that the only blanching with chemical treatment retains Fe and Mn and blanching treatment reduces the content of trace minerals. However it is surprising to note that SD-CT and CD-CT samples retained more minerals as compare to blanching.

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