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Salt substitute from banana plant (*Musa- balbisiana* Colla)

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ABSTRACT

With improvement of global economic affordability high intake of ready-to-eat salty foods has become a part of life and people are increasingly facing health risks including high blood pressure associated with high intake of table salt (NaCl). The United States Department of Health and Human Services recommends that individuals consume not more than 2300 mg of sodium per day against 4700 mg of potassium which is more than twice of sodium. Higher dietary potassium intakes may help in significantly lowering blood pressure. Potassium chloride may flavor our food at the same time lower the limit of sodium intake thus helping to lower blood pressure and other physiological anomalies connected with high sodium intake. To lower sodium intake salt substitutes are one option where some or all of the sodium chloride in table salt have been replaced by potassium chloride. An excellent salt substitute, with potassium to sodium ratio in the same breath as in nature, has been derived from banana plant. The salt substitute contains nearly 46% of potassium and 2.6% of sodium. Presence of certain beneficial metals in trace level is an additional feature of the salt substitute.

Key words: Salt**,** *kolakhar*, pseudo-stem, *bhim kol*.

INTRODUCTION

Table salt, also simply referred to as salt, is a crystalline mineral that is composed primarily of sodium chloride. The taste of salt (saltiness) is one of the basic human tastes sensations and it is the most essential commodities in our daily cooking. Salt is added in most food items, by the food processor or by the consumer, as a flavor enhancer, preservative, binder, fermentation-control additive, texture-control agent and color developer. Chloride and sodium ions, the two major components of salt, are needed by all known living animals and plants in small quantities, but harmful in large excess. Salt is involved in regulating the water content (fluid balance) of the body. The sodium ion itself is used for electrical signaling in the nervous system [1]. The increasing rate of consumption of table salt in modern living has become one of the major factors, which is inducing health risks associated with high salt intake, including high blood pressure in sensitive individuals. Too much or too little salt in the diet can lead to muscle cramps, dizziness, or electrolyte disturbance, which can cause neurological problems, or death.

The United States Department of Health and Human Services recommends that individuals consume 1500–2300 mg of sodium (3750–5750 mg of table salt) per day depending on age. Any excess of this amount can inhibit the proper absorption of nutrients and disrupt normal body functions. The seven dangerous health consequences of eating too many salty foods are hypertension, abnormal heart development, osteoporosis, kidney disorder, dehydration and swelling, digestive diseases and electrolyte and hormone imbalance.

Use of salt substitute is an alternative way to flavor our food and limit sodium intake to help lowering blood pressure and other physiological anomalies associated with blood pressure. Salt substitutes replace some or all of the sodium with potassium. Salt-free products are 100 percent potassium chloride, while reduced-salt or lite-salt substitutes contain a mix of sodium and potassium chlorides. The recommended daily allowance of potassium is higher than that for sodium [2] yet a typical person consumes less potassium than sodium in a given day. An individual, who intakes relatively high dietary potassium, has lower blood pressure compared to those whose intake of potassium is relatively low [3]. The Third National Health and Nutrition Examination Survey (NHANES III) reported that higher dietary potassium intakes were associated with significantly lower blood pressures [4]. It is reported that the Na/K ratio in our body is of great concern to prevent high blood pressure and the ratio should be less than one [5]. In a recently published report on several wild vegetables [6] Saikia & Deka have observed that all the vegetables studied have Na/K ratio less than one, and therefore consumption of those vegetables should be beneficial for the control of high blood pressure.

Banana is the second highest produced fruit contributing about 16% of the world's total fruit production [7]. India is the largest producer of banana, contributing 20% of world's banana production [8]. The plant gives fruits only once a life and produces pseudo-stems, on the average, not less than 7 times the mass of its fruits. However the pseudo-stem finds virtually no post-harvest use and is simply a waste. In north east of India, an aqueous extract called *kolakhar*, is prepared from the ash obtained by burning the air-dried pseudo-stem. *Kolakhar* finds several uses in rural north east of India including uses as a food additive and salt substitute [9]. Inorganic elements present in banana plant have a negative effect on the Kraft pulping, paper quality and yield [10-13]; thus, their high content in banana pseudo-stem is considered as a serious disadvantage when the pseudo-stem is considered as a raw material for pulp and paper production.

The idea of this article is to report how best the banana pseudo-stem can be used to produce a salt substitute for commercial exploitation.

EXPERIMENTAL SECTION

Plant materials

Amongst the different species of banana plants available in north east of India including Assam, the pseudo-stem of *Musa balbisiana* (popularly called *bhim kol* or *athia kol* in Assamese) was considered for this experiment because the plant of this species is easily available in Assam and has a large and stout pseudo-stem.

The post-harvest trunk or pseudo-stem was collected from local banana farm at Dhakuakhana, district Lakhimpur, Assam. The plant pseudo-stem was cut crosswise into several parts; each part was sliced lengthwise into small pieces. These were then dried under sun for several days in open air. The dry material was burnt completely into ash. The ashes were then allowed to cool in a desiccator and preserved in an air tight polythene bag.

Preparation of water extract

A mixture of 25 g of dry ash and 500 mL of distilled water taken in a one liter conical flask was stirred magnetically for one hour. It was then filtered and the residue washed with distilled water. The light yellow filtrate, known as *kolakhar*, was first reduced to 500 mL by evaporation before taking it for further analysis by chemical and spectroscopic techniques.

Measurement of pH of *kolakhar* samples

The pH of *kolakhar* samples were recorded with the help of a digital pH meter (Eutech Instrument, pH 510, pH/mV/ ^{0}C meter). Procedure given in the manual was followed. The meter was calibrated using buffer capsules of pH 4, pH 7 and pH 10.

Procedures involved in physicochemical investigation on *kolakhar*

Standard procedures [14] were followed for quantitative analysis of *kolakhar* to estimate the quantities of carbonate (CO_3^{2-}), chloride (Cl^-), nitrate (NO_3^-), phosphate (PO_4^{3-}), sodium (Na^+) and potassium (K^+). Carbonate (CO_3^{2-}) was estimated by volumetric method by titrating against a standard hydrochloric acid solution using methyl orange as the indicator. Chloride (Cl^-) in *kolakhar* was estimated by gravimetric method using $AgNO_3$ solution [14]. The concentration of nitrate ion (NO_3^-) in a *kolakhar* sample was estimated by measuring absorption at 275 nm in a using UV spectrometer (U-3210 spectrometer, Hitachi). The *kolakhar* samples were diluted to ten times of its original

volume and acidified using 1 N HCl to prevent interferences due to the absorption either by OH^- or CO_3^{2-}. For the estimation of phosphate content in *kolakhar*, samples were diluted to 5 times of its original volume and reported standard procedure was followed [15].

Na^+ and K^+ were estimated by Flame Photometry (Systronics, Flame Photometer 128). The sample for Flame Photometry was prepared by diluting 100 times of its original volume and the estimation of Na^+ and K^+ was carried out following standard procedure as reported [16].

The presence of a few trace metals of biological significance in *kolakhar* was examined by Atomic Absorption Spectroscopy (Varian Spectra AA- 220). For this experiment, 50 ml of the sample solution was made strongly acidic with 6 ml concentrated HNO_3 and evaporated to near dryness. It was then cooled to room temperature and the residue dissolved in distilled water and filtered. The filtrate was transferred to 50 ml volumetric flask and the volume made up to the mark with distilled water. The solution so prepared was taken for the estimation of trace metals by Atomic Absorption Spectroscopy [17].

Preparation of salt substitute from *kolakhar*

The *kolakhar* sample was treated with 1 M HCl drop wise just to neutralize it (pH = 7). The neutral solution was then evaporated to dryness and allowed to cool in a desiccator. The white crystalline solid mass obtained is the salt substitute.

RESULTS AND DISCUSSION

Banana pseudo-stem is highly rich in water which accounts for about 95% of mass. A sample of raw pseudo-stem weighing 25 kg yielded only 1.143 kg of air-dry material which in turn gave 190.9 g of ash after burning (**Table 1**). A sample of *kolakhar* derived from this ash showed that K^+ and CO_3^{2-}, 19.4% and 13.4% respectively, are the two major constituents present in the ash (**Table 2**). Other soluble constituents account for about 6%. Soluble constituents are together account for about 39% of the ash and the rest of the mass is water insoluble.

Table 1: Raw mass and dry weight of banana pseudo-stem

Entry	Materials	Weight (kg)
1	Weight of banana raw pseudo-stem	25.000
2	Weight of dry material	1.143
3	Weight of ash	0.191
4	Weight of salt substitute obtained from 25 g of ash (500 mL *kolakhar*)	0.105

Table 2: Spectral Analysis of *kolakhar*

Entry	Ion	ppm	% in ash	% in dry material
1	Na^+	550	1.100	0.184
2	K^+	9691	19.382	3.237
3	Cl^-	2210	4.420	0.738
4	CO_3^{2-}	6694	13.384	2.231
5	NO_3^-	83	0.166	0.028
6	PO_4^{3-}	230	0.460	0.077

About 10.5 g of salt substitute was obtained from 500 mL of *kolakhar* by evaporation. Composition of the salt substitute is shown in **Table 3**. Analysis shows that K^+ alone accounts for about 46% of the salt substitute while Na^+ accounts for less than 3%. Some of the trace elements were also detected and estimated in *kolakhar* as well as in the salt substitute. Their quantities, as estimated by flame photometry and atomic absorption spectrometry, are shown in **Table 4** and **Table 5**.

Table 3: Spectral Analysis of 10.524 g of the salt substitute

Entry	Ion	Quantity in g	Quantity in %
1	Na^+	0.275	2.61
2	K^+	4.845	46.04
3	Cl^-	5.075	48.22
4	NO_3^-	0.041	0.39
5	PO_4^{3-}	0.115	1.09

Table 4: Trace metals in the *kolakhar*

Entry	Metals	ppm	Entry	Metals	ppm
1	Al	5.241	7	Mg	0.582
2	Cd	0.009	8	Mn	0.023
3	Co	0.014	9	Ni	0.204
4	Cr	0.028	10	Pb	0.007
5	Cu	0.143	11	V	0.380
6	Fe	1.636	12	Zn	0.461

Table 5: Trace metals in the salt substitute

Entry	Metals	mg/100g	Entry	Metals	mg/100g
1	Al	24.900	7	Mg	2.765
2	Cd	0.043	8	Mn	0.109
3	Co	0.057	9	Ni	0.969
4	Cr	0.133	10	Pb	0.033
5	Cu	0.679	11	V	1.805
6	Fe	7.773	12	Zn	2.190

Al and Fe are the only two trace elements present in significant amount in both *kolakhar* and the salt substitute. Other trace elements, although their presence detected, are present only in quite insignificant amount. Cr(VI) and Fe(III) contents in any salt substitute can probably be reduced, if desired, by using *Azadirachta indica* (neem) and *Strychnos potatorum* (nirmali) seeds [18].

It is interesting to note that nearly 46% of the total mass of the salt substitute is potassium against 2.6% of sodium. On the other hand presence of potassium in table salt is almost negligible while sodium is present to the extent of 39%. Less sodium and high potassium, which are present in the same breath as in nature, makes the salt substitute more suitable for human health by reducing the risk of high blood pressure and cardiovascular disease associated with a high intake of sodium. Trace elements present in the salt substitute may also be an added advantage for the human health. These trace metals are essential minerals, and they play a vital role in our body function. They act as co-factors for enzyme reaction, maintain pH within the body, maintain proper nerve conduction, help to contract and relax muscles, help to regulate our body's tissue growth, provide structural and functional support for the body etc. [19]. The Food and Nutrition Board, The Institute of Medicine, National Academies have recommended the adequate intakes for individuals of age group 31-70 year [20]. The Joint Expert Committee on Food Additives (JECFA) of the Food and Agriculture Organization of the United Nations/World Health Organization and the European Commission's Scientific Committee on Food have set an acceptable daily intake (ADI) for nitrate of 0–3.7 mg nitrate ion/kg body weight. It appears that the intake of the salt-substitute derived from the banana pseudo-stem should be safe for healthy neonates, children, and adults [21,22].

CONCLUSION

A salt substitute, rich in potassium, has been derived from banana pseudo-stem (variety *Musa balbisiana*). Post-harvest banana pseudo-stem has no commercial value, and hence preparation of a salt substitute from this waste biological mass is an innovative idea. The salt substitute is likely to be an ideal commodity for those who are suffering from and/or prone to high blood pressure due to high sodium intake. Another important feature attached to this salt substitute is that potassium and sodium are presence in the same breath as in nature.

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