

## Chemical analyses of salt-substitutes derived from Phelo and its role in the health care system of the local indigenes

### Análisis químicos de sustitutos de la sal derivados de Phelo y su papel en el sistema de salud de los indígenas locales

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#### ABSTRACT

Today salt is the most desired and routinely added major food ingredient used in many food preparation and food processing technologies as well as in many therapeutic purposes. The taste of salt or saltiness is universally accepted by the human society since time immemorial. There are many literatures describing about the modern human civilizations obtaining salt from different sources to satisfy their gustatory senses. Likewise, the Karbi tribe, a hilly tribe of Assam, India, have been observed practicing extraction of a liquid condiment as salt-substitute from different plants and plant parts since time immemorial. The extracted condiment is known as Phelo in the region and it provides a unique flavour and many essential minerals to the local diets. But at present it is observe that such salt-alike condiment extraction practice is vanishing from this region because of replacement of these local condiments with the commercially available refined salts and soda powder. Therefore, the present study was an attempt to help uncover the forgotten salt resources and transform these liquid condiment used as salt-substitute to a solid form and also highlight its therapeutic potentialities. Today many man-made harmful food ingredients and food additives causing many deleterious health issues are the main cause of concern among the people, so the present study will provide a new herbal salt-substitute with an up-to-date nutritional information which is very natural and safe for human consumption.

Keywords: Salt, Therapeutic, Salt-substitutes, Practice, Alkaline

#### RESUMEN

Hoy en día, la sal es el ingrediente alimentario principal más deseado y agregado de forma rutinaria que se utiliza en muchas tecnologías de preparación y procesamiento de alimentos, así como en muchos propósitos terapéuticos. El sabor salado o salado es universalmente aceptado por la sociedad humana desde tiempos

inmemoriales. Hay muchas literaturas que describen cómo las civilizaciones humanas modernas obtenían sal de diferentes fuentes para satisfacer sus sentidos gustativos. Asimismo, se ha observado que la tribu Karbi, una tribu montañosa de Assam, India, practica la extracción de un condimento líquido como sustituto de la sal de diferentes plantas y partes de plantas desde tiempos inmemoriales. El condimento extraído se conoce como Phelo en la región y proporciona un sabor único y muchos minerales esenciales a las dietas locales, pero en la actualidad se observa que la práctica de extracción de condimentos similares a la sal está desapareciendo de esta región debido al reemplazo de estos condimentos locales con las sales refinadas y el polvo de soda disponibles comercialmente. Por lo tanto, el presente estudio fue un intento de ayudar a descubrir los recursos salinos olvidados y transformar estos condimentos líquidos utilizados como sustituto de la sal en una forma sólida y también resaltar sus potencialidades terapéuticas. Hoy en día, muchos ingredientes y aditivos alimentarios dañinos hechos por el hombre que causan muchos problemas de salud nocivos son la principal causa de preocupación entre las personas, por lo que el presente estudio proporcionará un nuevo sustituto de la sal a base de hierbas con una información nutricional actualizada que es muy natural y seguro para el consumo humano.

Palabras clave: sal, terapéutica, sustitutos de la sal, práctica, alcalina

## INTRODUCTION

Salt is probably the first and the oldest condiment discovered by humans and it is also the most commonly used food additives by the present day human civilizations. The taste of salt (saltiness) is one of the basic human tastes sensations and it is the most essential commodities in our daily cooking (Neog and Deka, 2013). Right amount of salt is very much needful for our body to perform its metabolic activities. Salt, a very useful trade commodity has been the subject of interest since its discovery and inception to humans (Gopalakrishnan, 2015). Depending on its availability, people from different regions since ancient times uses several different types of salt or salt-like additives derived from different sources for cooking. These includes refined commercial (table) salt (NaCl), a crude indigenous (ground) salt, salt precipitated from saline lakes, and also salt from the ash of plants or plant parts (Tara et al., 2016; Ohtsuka et al., 1987). It is observed that salts of plant origin is the main source of salt (NaCl) in some regions of the world where salt (NaCl) is unavailable. In India, the Karbi tribe, a major ethnic group residing in majority in the hilly district of Karbi Anglong of state Assam since time immemorial has been extracting a liquid condiment as salt-substitute to fulfil their salt requirement from five different plants namely *Musa balbisiana* (peels), *Carica papaya* (stems), *Brassica nigra* (whole individual plants after harvest), *Dendrocalamus hamiltonii* (stems) and *Sesamum indicum* (whole individual plants after harvest). Locally extracted condiment is known as Phelo in the region. Phelo is obtained by burning the mentioned plant to ash and then filtering it, the filtrate obtained is then called Phelo and is used as salt to supplement their salt requirement or as an additive for alkaline cooking by the Karbis. It is highly alkaline in nature and salty in taste. Cuisines cooked with Phelo are locally known as Kangmoi-han and is one of the

most desired cuisines among the Karbis and the other friendly indigenous groups in the region. The local indigenes consider Kangnoi-han as very nutritious and healthy diet and they also believe that regular consumption of Kangmoi-han helps relief from certain stomach problems. The main reason for the Karbi group of people enjoying such unique salt extraction practice is the physical features of their land accompanied by their confinement to the region. The taste of Phelo is culturally preferred in the region and in Karbi Anglong Phelo is ever present in the diet of the local people. But in present day modern culinary heritage of the Karbi tribe it is observed that the practice of using Phelo as salt-substitute is only limited to the people living in rural areas where bio-resources are rich and market supplies are not organized. The main reasons for its loss from the urban areas are that people in urban areas mainly depend more on ready-to-use soda powder for alkaline cooking and its salt requirement is fulfilled by the commercially available common salts. The other reasons include lack of nutritional data on these salt-like traditional condiments or compounds, Phelo, and also the preparation of Phelo is time consuming and cannot be stored in liquid form for longer periods resulting in vanishing of this age-old traditional knowledge of salt extraction. To date no scientific reports have been reported about Phelo from the region although it is the most used condiment by the locals in their exotic culinary preparation and also in many therapeutic purposes. Therefore, this paper is an attempt to transform these liquid salt-substitutes derived as Phelo to a solid form by traditional method of evaporation and analyse its salt properties. This report may help to revive the long forgotten salt resources and provide us with an up-to-date scientific information regarding the elemental compositions of the extracted salt-substitutes and will help the present day modern society get an ingredient which is natural, with many therapeutic potentialities as today most of the people prefer for naturalness in food and food ingredients.

## MATERIALS AND METHODS

Preparation of Phelo and derivation of salt-substitutes by evaporation method: Prior to extraction of Phelo the ash of the named plants *Musa balbisiana*, *Carica papaya*, *Brassica nigra*, *Dendrocalamus hamiltonii* and *Sesamum indicum* were collected from different localities of Karbi Anglong district according to their availability and brought from the field to the laboratory with the help of local people in five different zip lock plastic bags which were marked by plant names accordingly from which they were ashes. Then one by one each ash sample was transferred into five different Phelo-bisir (a conical shaped like bamboo crafted traditional tool used by the locals for sieving Phelo) and fresh water was added from above, when water leach through the ash and escaped at the bottom it was collected in bottles, which was called Phelo. The five different Phelo samples extracted were then evaporated to dryness in five different porcelain crucible with traditional sand-bath method and allowed to cool. The white crystalline solid mass obtained were the salt-substitutes. The salt-substitutes were then collected in airtight container, marked and stored under room temperature for chemical analyses.

Physicochemical analysis of salt-substitutes: The physicochemical analyses was done according to the methods described in Indian standard: Specification for edible common salt (Third edition) ("IS 253 (1985): edible common salt,").

Determination of moisture content: About 20g of the sample was weight and dried in an oven at 150°C for four hours. Then cooled in a desiccator and weighted. The process of drying, cooling and weighing was repeated until constant mass was obtained. It was calculated as follows:

$$\text{Moisture \%} = \frac{M_1 - M_2}{M_1} \times 100$$

Where,

M1 = Initial mass in gram

M2 = Final mass in gram

Total alkalinity: About 4.4g of sample was weighted and dissolved in 100ml of freshly boiled and cooled water in a conical flask and 5 drops of methyl orange and 50ml of standard hydrochloric acid (1N) was added to it. The content was then stirred thoroughly and was titrated with standard hydrochloric acid (0.1N) until the colour change from orange to red. It was calculated as follows:

$$\text{Total alkalinity (as NaHCO}_3\text{), \% by mass} = \frac{8.4VN}{M}$$

Where,

V = Volume in ml of standard hydrochloric acid (1N) required for titration

N = Normality of standard hydrochloric acid used

M = Mass in g of the sample

Particle size: About 100g of sample was taken and sieved. The sample retained at 1mm sieve was calculated as follows:

$$\text{Passing \%} = \frac{\text{Total weight of sample passed}}{\text{Total weight of sample retained}} \times 100$$

Matter insoluble and matter soluble in water: For matter insoluble, about 20g of the sample was dissolved in 200ml of water and then boiled and cooled. After cooling the solution was filtered through a weighed gooch crucible and washed the residue till it was free from soluble salts. The crucible was then dried with the insoluble residue to constant mass. It was calculated as follows:

$$\text{Matter insoluble in water \%} = \frac{M_1}{M_2} \times 100$$

Where,

M1= Mass in g of the residue

M2= Mass in g of the sample taken

Matter soluble was calculated by subtracting from 100 the matter insoluble in water.

Determination of sodium chloride (NaCl) and potassium chloride (KCl)

Sample preparation: About 20g of dried sample was dissolved in 200ml of water in a beaker and was heated to boiling and cooled. The solution was then filtered through a weighed gooch crucible and the residue was washed till it was free from soluble salts. The filtrate was collected in a one litre-graduated flask and diluted to the mark and was used for estimation of sodium chloride NaCl and potassium chloride (KCl).

For NaCl, from the prepared filtrate solution about 10ml was transferred into a conical flask and 1ml of potassium chromate indicator solution was added and was titrated against standard silver nitrate solution till the reddish brown tinge persist after shaking. It was calculated as follows:

$$\text{Sodium Chloride (as NaCl) \%} = \frac{VN}{M} \times 584.5$$

Where,

V = volume in ml of silver nitrate used in titration

N = normality of standard silver nitrate solution

M = mass in gram of the dried sample in 1000ml of the solution taken

For KCl, estimation, about 50ml of solution was transferred to a 100ml conical flask and 3ml of concentrated hydrochloric acid was added to the solution. The mixture was then placed in an ice bath for 5 to 10 minutes. When the solution was cooled 20ml of previously cooled sodium tetraphenyl boron solution was added and again kept for cooling for 5 to 10 minutes. After cooling it was filtered using a gooch crucible and dried for about 1 hour at 120<sup>o</sup>C, then cooled in a dessicator and weighed. It was calculated as follows:

$$\text{Potassium (as K) \%} = \frac{M1}{M2} \times 218.20$$

Where,

M1 = mass in gram of the precipitate

M2 = mass in gram of the prepared sample taken in 1000ml

Then, potassium (as KCl) was obtained by multiplying the value of potassium obtained by a factor 1.906.

Sulphate content: About 20g of the salt sample was dissolved in 400ml of water in a beaker. The solution was then filtered. One drop of methyl orange and 10ml of dilute hydrochloric acid was added to the filtrate and was then boiled. Then 12ml of barium chloride was added drop by drop to the boiling and was continued to boil for 4 minutes till a granular precipitate was obtained. The mixture solution was then allowed to stand for 4 hours and filtered through a gooch crucible. The crucible was the dried to constant mass at 110<sup>o</sup>C and weighed. It was calculated as follows:

$$\text{Sulphate (as SO}_4\text{) \%} = \frac{M_1}{M_2} \times 41.13$$

Where, M1= mass in g of barium sulphate

M2= mass in g of sample taken

Elemental analysis of the salt-substitutes: Estimation of Calcium (Ca), Magnesium (Mg), Lead (Pb), Iron (Fe), Arsenic (As) and Aluminium (Al): The estimation of Ca, Mg, Pb, Fe, As and Al was done by Flame Atomic Absorption Spectrophotometric method.

Sample preparation for Flame Atomic Absorption Spectrophotometric: 1g of each sample was digested with 6ml of triacid [Conc. HNO<sub>3</sub> + Conc. H<sub>2</sub>SO<sub>4</sub> + Conc. HCl (4:2:1)] and evaporated to near dryness. It was then cooled at room temperature, dissolved in distilled water and then filtered. The filtrate was then transferred to a 50ml volumetric flask and the volume was made up to the mark with distilled water. The solution thus prepared was the used for the estimation of the elements by AAS method (Anjumani and Dibakar, 2020).

Iodine content: Iodine content was estimated by Iodometric titration method. About 10g of the salt sample was dissolved in 50ml double distilled water then 1ml of sulphuric acid (2N) and 5ml of 10% potassium iodide was added to the solution which in presence of iodine will turn yellow. The reaction mixture was then kept in dark place for 10 minutes and was then titrated with sodium thiosulphate (0.005N) using 2ml of starch as an indicator.

$$\text{Iodine \%} = \frac{\text{Titration volume(ml)} \times 21 \times 15 \times \text{normality of sodium thiosulphate} \times 1000}{\text{salt sample weight (gm)}}$$

## RESULTS AND DISCUSSION

It was observed that *Musa balbisiana*, *Carica papaya*, *Brassica nigra*, *Dendrocalamus hamiltonii* and *Sesamum indicum* were the five plants used for extraction of Phelo by the Karbi tribe and the results of chemical analyses of salt-substitutes derived from Phelo showed significant differences in their physicochemical and elemental compositions. Table 1 represents the physicochemical values of the derived herbal salt-substitutes. The moisture content range from 2.91- 10.36% (w/w). The highest value was observed in *Brassica nigra* and the lowest in *Musa balbisiana*. The FSSAI standard for moisture content for common edible salt is maximum 6%. In our estimation we found that moisture contents of salt-substitutes derived from *Musa balbisiana* (2.91%), *Dendrocalamus hamiltonii* (4.69%) and *Sesamum indicum* (3.62%) was in harmony with the FSSAI standard whereas the moisture content of salt-substitutes derived from *Carica papaya* (9.29%) and *Brassica nigra* (10.36%) exceeds the FSSAI standard value for common salt. Moisture content generally refers to the water present in a product and a low value of moisture content is always preferred for food additives and food grade salts. The less value of moisture content means that the salt is free flowing, remain in crystal form without forming lump and has the longer shelf life.

The alkalinity of salt-substitutes ranges from 30.09-61.78% (w/w). The highest alkalinity value was recorded in *Brassica nigra* and lowest in *Musa balbisiana*. The results of alkalinity values of salt-substitutes is an indicative that

they are highly alkaline in nature and can be a good replacer of food grade soda powder available for markets. Today for many researcher benefits from alkalies or alkaline products is one of the newer trends in health research. They belief that consumption of an alkaline product within a permissible range helps slow down the ageing process in humans, helps regulate the pH of the human body and prevent various chronic diseases.

Table 1: Enumeration of the determined physicochemical values of the five salt-substitute derived from Phelo

Parameters	<i>Musa balbisiana</i>	<i>Carica papaya</i>	<i>Brassica nigra</i>	<i>Dendrocalamus hamiltonii</i>	<i>Sesamum indicum</i>
	% (w/w)				
Moisture	2.91	9.29	10.36	4.69	3.62
Alkalinity	61.78	37.98	30.09	47.34	42.29
Matter in-soluble in water	0.54	0.15	1.72	1.23	3.90
Matter soluble in water	99.46	99.85	98.28	98.77	96.10
Particle size	-	0.86	0.68	0.98	0.72
Sulphates	18.14	28.01	38.90	29.58	24.47
Sodium chloride	13.07	11.45	7.34	10.61	7.04
Potassium chloride	5.90	11.39	10.19	11.24	9.30

The matter insoluble and matter soluble range from 0.15-3.90% (w/w) and 96.10-99.85% (w/w). According to FSS regulation and Indian standard the water-insoluble matter in salt should not be more than 1.0% by weight on dry basis. Among the five derived salt-substitute, *Musa balbisiana* (0.54) and *Carica papaya* (0.15) were within the specified limit. Whereas *Brassica nigra* (1.72), *Dendrocalamus hamiltonii* (1.23) and *Sesamum indicum* (3.90) were not within the specified limit by FSSAI. Since the processing and derivation of salt-substitute is done by simple traditional methods, the presence of higher concentration of insoluble matter may be due to exposure and settling down of dust particle while during the process of evaporation or could be from sand particles from equipment during production. The particle size of four salt-substitutes were of significant range (*Carica papaya*- 0.86%, *Brassica nigra*- 0.68%, *Dendrocalamus hamiltonii*- 0.98% and *Sesamum indicum*- 0.72%) except *Musa balbisiana* which was not measurable at 1mm sieve.

The sodium chloride (NaCl) content and potassium chloride (KCl) content of the derived salt-substitute ranged from 7.04-13.07% w/w and 5.90-11.39% w/w. The highest sodium chloride (NaCl) content was observed in *Musa balbisiana* and lowest was observed in *Sesamum indicum*. The highest potassium chloride (KCl) content was observed in *Carica papaya* and lowest in *Musa balbisiana*. From our study we found that sodium chloride (NaCl) content in *Musa balbisiana* and *Carica papaya* were higher than the potassium chloride (KCl) content and hence they are more sodium salt than potassium salt. Whereas *Brassica nigra*, *Dendrocalamus hamiltonii* and *sesamum indicum* were more potassium salt. Today the people around the world are concerned about the health risks factors mainly

high blood pressure problem associated with high intake of sodium chloride (NaCl). Hence a higher dietary potassium may be an alternative solution for the health risks factors associated with sodium intake. Potassium chloride (KCl) may flavour on 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 (Neog and Deka, 2013). The sulphate content of the derived salt-substituted was observed to be very high and ranged from 18.14-38.90% (w/w). The highest value of sulphate was observed in *Brassica nigra* and lowest value in *Musa balbisiana*.

The salt-substitutes derived from Phelo were observed to content many essential elements required for different metabolic functions in human body. Elemental compositions of the derived salt-substitutes are represented in

Table 2. The Calcium content in the salt-substitutes ranged from 0.60-5.20 ppm, highest value estimated in *Sesamum indicum* and lowest in *Dendrocalamus hamiltonii* and the magnesium content ranged from 0.50-11.50 ppm, the highest value observed in *Sesamum indicum* and lowest in *Dendrocalamus hamiltonii*. Iron content was observed to be ranged from 12.60-38.43 ppm, with highest value observed in *Brassica nigra* and lowest in *Musa balbisiana*. The highest value of potassium was estimated in *Carica papaya* (5.98 ppm) and lowest in *Musa balbisiana* (3.10 ppm). Aluminium was recorded highest in *Carica papaya* (1.20 ppm) and lowest in *Dendrocalamus hamiltonii* (0.92 ppm). The presence of calcium, magnesium, iron and aluminium in these salt-substitutes is an indicative property that these salt-substitutes can be used as a dietary salt rich in nutrients that human need much for a good metabolism. The heavy metal arsenic present in the salt-substitutes was estimated in lowest permissible limit. The arsenic content of all the five salt-substitutes were estimated below <0.05 ppm. On the other hand, the Lead content in salt substitutes was observed to exceed the maximum permissible limit by FSSAI (2.5 ppm). The maximum level of lead was observed in *Dendrocalamus hamiltonii* (18.55 ppm) and minimum level in *Musa balbisiana* (7.93 ppm). Lead content was recorded highest in all the salt-substitutes sample, it may be because all the salt-substitutes derived was in impure form. The lead content can be minimized by proper washing with water and recrystallization. The salt-substitutes were observed to have a significant amount of iodine content which ranges from <50 ppm to 253.70 ppm with the highest iodine content estimated in *Brassica nigra* and lowest estimated in *Musa balbisiana*. Today there are explosion of research papers and articles prioritizing iodine as an essential mineral which a body need for its proper functioning. The main source of iodine required for our body are iodized salts available in the markets. Some of the important health benefits of iodine reported are it ensure proper thyroid function, essential for proper brain development in babies, improved cognitive function in children, healthy birth weight, lower risk of goitres, treat fibrocystic breast disease and treat thyroid cancer (Zou et al., 2012; Gunnarsdottir and Dahl, 2012; Farebrother et al., 2015; Pires et al., 2017; Gorstein et al., 2020). More than 2 billion people in the world today suffer from micronutrient deficiencies caused largely by a dietary deficiency of vitamins and minerals (Phanice, 2016). Hence the salt-substitutes derived from Phelo can be a major source of minerals to the present human civilizations.

Role of Phelo in the healthcare of the local indigenes: The Karbi tribe is known for their dependence upon forest and forest products for their survival. Phelo is one such natural product which the Karbis loves extracting for its multifunctional uses. Phelo is the most socially and culturally important major ingredient cherished by the local



indigenes of the region. Its role in household cooking, in treating stomach problems as therapeutic agents, it uses in religious and cultural ceremonies and also its role in the regional trade cannot be overemphasized. Phelo is one of the major ingredients that every Karbi household store-inside. In a Karbi diet a dish cooked with Phelo is always considered as first dish. They belief cuisines cooked with Phelo as medicinal cuisines that helps cure stomach disorders and keeps the stomach clear and stimulate their body metabolism. It was observed that no religious ceremony or ritual in Karbi culture is complete without Phelo. A dish cooked with Phelo known as Kangmoi-han is ever present in the menu of Karbi cuisines in every religious ceremonies. It was also observed that Phelo is also used as a natural wound healer. The Karbis apply one or two drops of Phelo to a wound for its fast healing as antimicrobial agents. Phelo were also used as detergents for washing purposes by the Karbis. But today the uses of Phelo is observed only in rural areas of the region. Before the introduction of salt and soda powder or before industrialization, Phelo also use to be a source of income for the Karbis. But today Phelo are found to be sold only in Karbi Youth festivals, or in zonal festivals in the districts. By creating awareness in regards with the potentialities of derived salt-substitutes could generate a source of income for the local indigenes in the region.

Table 2: Enumeration of mineral content estimated from the five different salt-substitute derived from Phelo

Elements	Name of the samples					Units
	<i>Musa balbisiana</i>	<i>Carica papaya</i>	<i>Brassica nigra</i>	<i>Dendrocalamus hamiltonii</i>	<i>Sesamum indicum</i>	
Calcium	2.60	1.60	3.98	0.60	5.20	Ppm
Magnesium	2.50	1.90	2.42	0.50	11.50	Ppm
Lead	7.93	12.89	13.95	18.55	15.35	Ppm
Iron	12.60	33.86	38.43	15.83	33.92	Ppm
Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	Ppm
Potassium	3.10	5.98	5.35	5.90	4.88	Ppm
Aluminium	1.05	1.20	1.01	0.92	1.03	Ppm
Iodine	<50	169.10	253.70	126.80	124.60	Ppm

## CONCLUSION

This study is an attempt to popularize and bring out the positive aspects of a natural food additive called Phelo, both in its liquid form and derived-salt form, which the Karbis have been preserving as their traditional food additive since ancient time. The analyses results in the study support its potentialities as herbal salt-substitutes. Further studies are recommended to investigate the possibility of the salt-substitutes to be used as therapeutic salts and measure the doses or quantity limit pertaining to the salt-substitutes for its safe consumption.

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