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Synthesis of Low Sodium Salt from different Bittern, Salt and Brine Samples of various Salt-Pans of Kanyakumari District

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Abstract : In kanyakumari district, different salt-pans produce large quantities of common salt which are generally produced by using different types of brine samples. These common salt samples, the brine used for salt making and the bittern samples being let out as waste are being utilized for the generation of low sodium salt samples by adopting different methods. The formed low sodium salt samples were analyzed for the presence of different ionic composition. The production cost for the various low sodium salt samples by different methods were correlated with that of the samples available in the market.
Key Words : common salt, brine, bittern, low sodium salt, ionic composition

Introduction

Salt in general is a crystalline mineral made up of sodium and chlorine which is essential to human beings in different dimensions[1]. Regarding the different types of salt, refined salt, Himalayan Pink salt, Celtic salt etc proved their importance. Salt consumption has increased during modern times and scientists are made aware about the health risks[3].

In order to overcome the basic problems regarding the excess consumption of common salt, this inevitable commodity in different dimensions as low sodium salt was tried[4]. A low sodium diet is one that includes not more than 1500-2400mg of sodium per day[5]. In general, the human minimum requirement in sodium in the diet is about 500mg per day[6]. A low sodium diet has a useful effect to reduce blood pressure regarding hypertensive people.

As high levels of sodium lead to increased risk for hypertension, potassium helps to offset the adverse effect of sodium. Our body needs potassium to maintain proper pH level in body fluids and also plays a major role in regulating blood pressure.

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Materials and Methods

For the preparation of low sodium salt samples using bittern, salt and brine samples availed from different salt pans like Swamythopu, Puthalam and Kovalam, seven different methods were adopted. The first three methods ie I, II and III utilize the bittern samples from the three different salt pans while methods IV, V use the common salt samples available from the various salt pans. Method VI and VII make use of the brine samples from the source of the three different salt-pans.

Method – I

100 ml of bittern is treated with 3gm of calcium chloride to precipitate insoluble calcium sulphate which was separated to get the de-sulphated bittern. It was further evaporated and the salt deposited was removed to get the concentrated form of de-sulphated bittern. It was further treated with carnalitie and continued the evaporation till a solid mixture was deposited. The solid mixture was then separated and heated with water for 20-60 minutes with stirring to produce low sodium salt in equilibrium with bittern. The solid was separated and dried at a temp of 90^0-130^0C to get low sodium salt. The samples were weighed and labeled as LS1, LPI & LK1 corresponding to Swamythope, Puthalam and Kovalam salt pans respectively.

Method – II

The bittern from the three different pans was heated gently to obtain Kainite ie $MgSO_4.KCl.3H_2O$. The Kainite obtained was separated and 50ml of brine from source was added to make it into slurry, which was agitated in a mechanical stirrer for one hour to obtain a ppt and was filtered and dried to obtain low sodium salt. The samples was labeled as LS2, LP2 and LK2 corresponding to S.thope, Puthalam and Kovalam pans respectively.

Method – III

The bittern from the different salt – pans was evaporated to obtain Kainite, which was separated and brine from the source of three different pans were added to slight excess to make it into a clear solution. It was then evaporated to obtain a precipitate comprising NaCl and also $MgSO_4.K_2SO_4.6H_2O$ which is the low sodium salt labeled as LS3, LP3, LK3.

Method – IV

10gm of K_2SO_4, 3gm of $MgSO_4$ and 7gm of NaCl obtained from the three different salt-pans were taken in a blender. Fifteen minutes of blending was carried out followed by recrystallization to get fine crystals of low sodium salt and were named LS4, LP4 and LK4.

Method – V

10gm of KCl, 3gm of $MgSO_4$ and 7gm of NaCl obtained from the different salt pans were taken in a blender and blended for fifteen minutes followed by recrystallization to get crystals of low sodium salt and was labeled as LS5, LP5 and LK5.

Method – VI

10gm of K_2SO_4 and 3gm of $MgSO_4$ were blended well and then added 50 ml of brine from the source of different pans. The solution was made homogeneous and then evaporated to get low sodium salt and were designated as LS6, LP6 and LK6.

Method – VII

10gm of KCl and 3gm of $MgSO_4$ were blended well and then added 50ml of brine from the source of different salt pans. The solution was further evaporated to get the low sodium salt samples which were labeled as LS7, LP7, LK7.

The percentage of chloride, sulphate, calcium, magnesium, sodium and potassium present in the different low sodium salt samples derived through various methods were determined using standard procedures which was presented in Table I.

The standard specific composition of the low sodium salt samples was given in Table II.

The weight of the low sodium salt samples obtained through the different methods by using different salt – pan samples were presented in Table III.

Table I : Composition of different ions in the prepared low sodium salt samples

Methods	Salt.pans	$Cl^{(-)}$	$SO_4^{2(-)}$	$Ca^{2(+)}$	$Mg^{2(+)}$	$Na^{(+)}$	$K^{(+)}$	Weight of salt formed (gm)
I	S.Thope	14.30	32.50	0.35	7.23	4.31	15.84	6.216
	Puthalam	13.90	32.20	0.38	7.94	4.24	15.98	5.947
	Kovalam	14.70	32.80	0.41	7.01	4.68	15.92	6.197
II	S.Thope	10.08	40.03	0.28	5.12	4.18	14.37	5.759
	Puthalam	10.03	40.12	0.20	5.23	4.22	14.59	5.461
	Kovalam	10.24	40.32	0.26	5.09	4.28	14.42	5.570
III	S.Thope	10.06	40.09	0.26	5.11	4.20	14.25	6.480
	Puthalam	10.02	40.10	0.24	5.24	4.21	14.59	6.521
	Kovalam	10.26	40.30	0.26	5.10	4.27	14.36	6.151
IV	S.Thope	10.09	41.77	0.18	5.26	4.13	14.73	19.989
	Puthalam	10.03	41.52	0.19	5.28	4.16	14.90	19.952
	Kovalam	10.20	41.83	0.17	5.23	4.20	14.69	19.972
V	S.Thope	11.36	40.03	0.14	5.20	4.25	15.83	19.993
	Puthalam	11.24	40.08	0.13	5.30	4.20	15.86	19.989
	Kovalam	11.42	40.06	0.10	5.14	4.34	15.94	19.982
VI	S.Thope	10.08	41.58	0.23	5.34	4.07	15.68	5.823
	Puthalam	10.14	41.32	0.21	5.38	4.05	15.72	5.996
	Kovalam	10.18	41.65	0.18	5.32	4.10	15.60	6.199
VII	S.Thope	11.10	40.27	0.25	5.25	4.14	15.90	7.249
	Puthalam	11.08	40.25	0.29	5.29	4.10	15.96	7.479
	Kovalam	11.27	40.29	0.20	5.18	4.18	15.55	7.584

Table II: Std specific composition of low sodium salt

PARAMETERS	%
Chloride	10.21
Sulphate	40.55
Calcium	0.15
Magnesium	5.14
Sodium	4.17
Potassium	14.67

Table III: Weight of low sodium salt obtained through different methods

Method	Swamithope (LS) (gm)	Puthalam(LP) (gm)	Kovalam(LK) (gm)
I	6.216	5.947	6.197
II	5.759	5.461	5.570
III	6.480	6.521	6.151
IV	19.989	19.952	19.982
V	19.993	19.989	19.982
VI	5.823	5.996	6.199
VII	7.249	7.479	7.584

Results and Discussion

Regarding the synthesis of low sodium salt, seven different methods were adopted using bittern, salt samples and the different brine samples from various salt pans. The presence of various ions viz. chloride, sulphate, calcium, magnesium, sodium and potassium in the different low sodium salt samples synthesized were determined using standard procedure and were presented in Table I.

Methods utilizing bittern for low sodium salt making

The bittern samples were collected from the three different salt pans like Swamythopu, Puthalam and Kovalam. Regarding the method I, the yields are found to be 6.216gm for LS1 (low sodium salt of Swamy thopu using method I), 5.947 gm for LP1 (Low sodium salt of Puthalam using method I) and 6.197 gm for LK1 (low sodium salt of Kovalam sample using method I).

Regarding the yields using method II, it was found to be 5.759 gm for LS2, 5.461 gm for LP2 and that for LK2 it was 5.570gm. Considering the method III, the yields were found to be 6.480 gm for LS3, 6.521 for LP3 and 6.151gm for LK3.

Considering the ionic composition, the percentage of chloride for LS1 is 14.30, LP1 is 13.90 and that for LK1, it was 14.70. The maximum value for LK1 was mainly due to the reason that Kovalam uses sea brine for salt making. Moreover, the value of chloride was found to be higher than all the other samples synthesized by the other six methods and also the standard specific composition which was mainly because of the added of calcium chloride, magnesium chloride and potassium chloride which may reside in the low sodium salt crystallized.

Regarding the percentage of sulphate in the low sodium salt samples synthesized using bittern, the values were found to be minimum i.e. 32.50, 32.20 and 32.80 for LS1, LP1 and LK1 respectively when compared with all other samples prepared and also the standard specific composition values. This may be mainly due to the removal of excess sulphate as calcium sulphate in the methods adopted.

Considering the values of calcium, it was found to be 0.35 for LS1, 0.38 for LP1 and 0.41 for LK1. But the values of the other samples synthesized by methods II and III were comparatively low. This was evident in method I which involves the addition of calcium chloride to remove the sulphate as calcium sulphate may reside and in turn increase the percentage of calcium in the low sodium salt sample.

The values of magnesium were found to be the maximum i.e. 7.23 for LS1, 7.94 for LP1 and 7.01 for LK1 when compared to the other samples and also the std. specific composition. The reason being the fact that magnesium chloride in the form of carnallite is added which may reside along with the crystallized low sodium salt samples.

When the values of sodium are concerned, the values of LK1, LK2 and LK3 were found to be marginally higher than the others which may be due to the fact that Kovalam uses sea brine for salt making.

Regarding the values of potassium, it was found that LS1, LP1 and LK1 were having maximum values than LS2, LP2 and LK2. This may be the reason that due to the addition of potassium chloride as carnallite during the synthesis of low sodium salt.

Comparison of parameters of samples obtained from method I, II, III

Upon comparing the different parameters of low sodium-salt samples obtained by the above three methods which use bitten from the three different salt-pans, the percentage of chloride was found to be maximum in LK1 i.e. 14.78 and the minimum of 10.02 in LP3. In the case of sulphate, a maximum value of 40.32 was observed in LK2 while minimum value of 33.2 was recorded in LP1. Maximum percentage of calcium was observed in LK1 with a value of 0.41 and a minimum value of 0.20 in LP2.

The percentage of magnesium was maximum in LP1 with a value of 7.94 and a minimum of 5.09 in LK2. Regarding the value of sodium, it was maximum for LK1 with a value of 4.68 and a minimum of 4.18 was observed in LS2. Potassium was found to be maximum with 15.98 in LP1 and minimum in LS3 with a value of 14.25.

Methods utilizing common salt for preparing Low sod. Salt

In the synthesis of low sodium salt, methods IV & V use common salt as one of the ingredients and use the blending method. Regarding method IV, the yield of the low sodium. salt from the different pans is 19.989, 19.952 & 19.972 gms for LS4, LP4, LK4 respectively. In method V, the yields are 19.993 for LS5, 19.989 for LP5 and 19.982 gm for LK5.

Considering the concentration of various ions in the low sod. salt samples prepared from the different salt samples of different salt-pans, it was found that the percentage of chloride was in agreement. But the values of sulphate were found to be higher when compared to the standard specific composition. This is because of the fact that the addition of potassium and magnesium sulphate during the synthesis of these low sodium salts.

Regarding the percentage of Ca2+, Mg2+ & Na+ the values of the low sodium salt samples were in agreement and the std. specific composition of the low sodium salt. But the percentage of K+ was found to be higher and this may be due to the addition of a maximum amount of potassium sulphate in the method adopted for the synthesis of the low sodium salt samples.

Comparison of parameters of samples obtained from method IV & V

Among the samples obtained by using methods IV & V, the percentage of chloride was found to be maximum for method V. which may be due to the addition of Kcl for the synthesis. The maximum value of 11.42 was observed at LK5 and a minimum value of 10.03 at LS4. The percentage of sulphate was maximum in LS4, LP4 & LK4 and minimum value was observed in LS5, LP5 & LK5. This may be due to the addition of potassium sulphate for the synthesis of low sodium salt in method IV.

The percentage of calcium had almost similar values in the samples obtained from the two different methods. Regarding the percentage of magnesium, it was also found to be similar in both the methods as equal amounts of magnesium sulphate was added. The percentage of sodium was found to be almost similar in the samples obtained by the two methods. Considering the percentage of potassium, it was also found to be similar for all the samples prepared by the two different methods.

Methods utilizing brine for preparing low sodium salt

In the synthesis of low sodium through the methods VI & VII, they utilize the blending cum dissolution method which involves the addition of brine. Regarding the yields in method VI, it was found to be 5.823gm, 5.996 gm of 6.199 gms for LS6, LP6 & LK6 respectively. But in the case of method VIII, it was 7.249 gm for LS7, 7.479gm for LP7 and 7.584 gm for LK7.

Regarding the concentration of various ions in the low sodium salt samples prepared by these methods, the percentage of chloride for the samples prepared by method VI, was found to be in agreement with the std values. But, the values were found to be more for the samples prepared by method VII as more quantity of potassium chloride was added for the synthesis. Likewise in the case of sulphate, it was found to be more in the samples by method VI as more quantity of potassium sulphate is added for the synthesis.

Considering the values of Ca2+, Mg2+ and Na+ all the samples exhibit the values which were in agreement with the standard specific composition of the low sodium salt. When the percentage of potassium is concerned, as expected it was found to be maximum for all the samples by the two different methods as they involve the addition of excess potassium sulphate in method VI and excess potassium chloride in method VII.

Comparison of parameters for samples obtained by methods VI & VII

The percentage of chloride was found to be maximum for the samples of method VII as they involve the addition of KCl in the method while the percentage of sulphate was maximum in the samples of method VI than VII as this method utilize the incorporation of more amount of sulphates of potassium and magnesium.

Regarding the percentage of calcium, all the samples of methods VI & VII had almost similar values. Likewise, the percentage of Mg2+ is also similar for all the samples as equal amounts of magnesium salts were added in the two methods. The percentage of sodium and potassium were also almost similar for all the samples obtained through different methods VI & VII.

Comparison of cost of production

In general, the success of any commodity normally produced must reach the public utility at a comparatively lower cost alone is important. Here also, the low sodium salts are synthesized by utilizing the salt –pan commodities like salt, brine and bitten with different methods. The quality and quantity of the different low sodium salt samples synthesized by the seven different methods were found to be satisfactory.

Out of the seven different methods for the synthesis of low sodium salt, method V utilizes the blending of common salt with potassium chloride and also some magnesium sulphate while method VII incorporated the blending of potassium chloride and magnesium sulphate and the mixture was dissolved with the brine from the source and then subjected to evaporation for getting the low sodium salt samples. By adopting these methods, we can synthesise the low sodium. salt samples at a very cheaper rate when compared with industrial production. This is because in the above methods, the required potassium chloride and magnesium sulphate can be availed at a lower rate and sodium chloride and the brine can be obtained from the salt pans. The samples thus obtained were subjected to recrystallization to get the purest variety of low sodium salt.

Another method involves the treatment of bittern with calcium chloride to form the required low sodium salt sample. In this method, the bitten which is normally discarded as a toxic waste can be utilized as such while calcium chloride can be availed and that also at a cheaper rate. Considering the bittern samples from different salt-pans, sea bittern is having more quantity of calcium chloride than the sub-soil and back water bittern samples. Even then, the production of low sodium salt can be possible at a very cheaper cost when compared with the industrial production.

This was because of the fact that calcium chloride can be availed from the market at a chapter cost and once the low sodium salt samples were prepared, they were separated and subjected to recrystallization to get the purest form possible.

Conclusion

It was found that the prepared low sodium salt samples through different methods by utilizing bittern, brine and salt samples were having the needed nutrients to the permissible limit as per the standard specific compositions. Thus the unwanted by-product of the solar salt-pan i.e. bittern can be converted into useful and medicinally important low sodium salt. ie “WASTE CAN BE CONVERTED INTO WEALTH”.

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