# CHANGE IN THE MINERAL COMPOSITION OF PHYTATES

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The mineral composition of phytin has been studied as a function of the variety of the source of raw material and the possibility of its change during the process of isolation.

Phytin is the hexaphosphate of the hexahydric cyclic alcohol mesoinositol in the form of calcium and magnesium salts and is widely used in medicinal practice [1]. In the phytin molecule, the ions of the alkaline-earth metals replace the hydrogen ions of the hydroxy groups of phytic acid. The cationic composition of the metals in its structure plays an important role in determining the properties of this compound. The USSR State Pharmacopeia (10th edition), while referring to the presence of calcium and magnesium as components of phytin, does not give their quantitative characteristics and does not standardize the metal content. There are publications showing the possibility of a change in the mineral composition of phytin both according to the conditions of growth of the plants and to the technology of its isolation [2-5].

It is known that in the human organism calcium plays the role of an intracellular regulator, while magnesium ions take an active part in many enzymatic reactions (particularly in glycolysis and ATP-dependent reactions [6]); consequently, both a qualitative and a quantitative variation in the mineral composition of medicinal phytin will change its biological properties. In view of this, the absence of conclusive investigations in this direction is preventing the development of objective methods for standardizing the quality of phytin produced by industry.

The aim of the present work was to study the mineral composition of samples of phytin-containing plant materials and of the phytin obtained from them and also the possibilities of regulating the mineral composition of the final product. Samples of rice bran and cottonseed meal produced by the Uzbekistan industry, of commercial phytin, and of phytin obtained under laboratory conditions by different methods have been investigated.

The method of obtaining commercial phytin consists in extracting the phytin from the plant material by the action of nitric acid and precipitating it from the extract by the addition of an aqueous solution of ammonia [7]. Laboratory samples of phytin with a large amount of calcium ions were obtained by a modified method [8]. The amounts of metal ions in the solutions were determined on a Pye Unicam atomic absorption spectrophotometer (United Kingdom).

To calculate the percentage contents we used the method of limiting standard solutions. Values of the concentrations of metal ions in solutions of a blank experiment conducted through all the stages of analysis apart from taking the sample were obtained. The results are given in Table 1.

From the results of the mean values of the percentage mineral compositions of the samples it can be seen that rice bran and cottonseed meal as phytin-containing sources of raw material contain far more potassium and magnesium than calcium and sodium. This is apparently explained by the particular role of these cations in the life of the plants, and also by the chemical composition of the soil. Both in the industrial and in the experimental samples of phytin the mineral composition was due mainly to the presence of magnesium and calcium cations. The reason for this is that with alkaline-earth metals inositol phosphates

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TABLE 1. Metrological Characteristics of the Average Results of a Determination of the Mineral Compositions of the Samples (n = 3, P = 0.95)

| Mineral compositions | Mean value $\bar{X}n$, % | Mean square deviation $S = \sqrt{\frac{\Sigma(\bar{X}n - Xn)^2}{n(n-1)}}$ | Half-width of the confidence interval Δ = St | Results of the determinations |
|---|---|---|---|---|
| Rice bran | | | | |
| Sodium | 0,014 | 0,0009 | 0,0039 | 0,014±0,004 |
| Potassium | 1,0 | 0,0261 | 0,1122 | 1,00±0,11 |
| Magnesium | 0,72 | 0,0091 | 0,0391 | 0,72±0,039 |
| Calcium | 0,066 | 0,0020 | 0,0086 | 0,066±0,09 |
| Industrial sample of phytin | | | | |
| Sodium | 0,060 | 0,0006 | 0,0026 | 0,060±0,003 |
| Potassium | 0,59 | 0,0135 | 0,0581 | 0,59 ±0,06 |
| Magnesium | 14,24 | 0 0842 | 0,3621 | 14,21±0,36 |
| Calcium | 2,56 | 0,0524 | 0,2253 | 2,56 ±0,23 |
| Experimental sample of phytin No. 1 from rice bran | | | | |
| Sodium | 0,003 | 0,0006 | 0,0026 | 0,003±0,003 |
| Potassium | 0,062 | 0,0013 | 0,0058 | 0,062±0,006 |
| Magnesium | 6,48 | 0,0869 | 0,3738 | 6,48±0,37 |
| Calcium | 10,30 | 0,0960 | 0,4128 | 10,30±0,41 |
| Experimental sample of phytin No. 2 from rice bran | | | | |
| Sodium | 0,028 | 0,0006 | 0,0026 | 0,0028±0,003 |
| Potassium | 0,026 | 0,00168 | 0,0072 | 0,026 ±0,007 |
| Magnesium | 3,85 | 0,0115 | 0,0495 | 3 85 ±0,05 |
| Calcium | 9,59 | 0,1015 | 0,4365 | 9,59 ±0,44 |
| Cottonseed meal | | | | |
| Sodium | 0,0051 | 0,0002 | 0,001 | 0,005±0,001 |
| Potassium | 1,800 | 0,0492 | 0,210 | 1,800±0,21 |
| Magnesium | 0,740 | 0,0173 | 0,074 | 0,740±0,7 |
| Calcium | 0,170 | 0,0091 | 0,039 | 0,170±0,04 |
| Experimental sample of phytin No. 3 from cottonseed meal | | | | |
| Sodium | 0,003 | 0,0002 | 0,001 | 0,003±0,001 |
| Potassium | 0,017 | 0,0012 | 0,005 | 0,017±0,005 |
| Magnesium | 11,78 | 0 0570 | 0,245 | 11,78±0,25 |
| Calcium | 2,450 | 0,1015 | 0,436 | 2,450±0,430 |

give neutral salts that are insoluble in water, while their salts with the alkali metals dissolve readily in water, and therefore at the stage of precipitating phytin in a neutral medium the sodium and potassium salts of inositol hexaphosphate remain in the mother solution. Industrial samples of phytin contained 0.06% of sodium and 0.59% of potassium. But the presence of these amounts of cations was due not to their being contained in the structure of the phytin molecule but to an inadequate purity of the product, since this was less than one equivalent per 1 mole of inositol hexaphosphate.

So far as concerns the quantitative ratio of calcium and magnesium in phytin samples, here considerable deviations were observed from the composition known from the literature, where five calcium atoms and one magnesium atom in the phytin molecule make up about 12 and 1.5%, respectively.

In an industrial sample of phytin obtained from heat-treated rice bran, however, a 5-times smaller amount of calcium was found (2.56%) and a 9.5 times greater amount of magnesium (14.21%). Laboratory samples of phytin obtained from cottonseed meal (sample 3) also contained a large amount of magnesium (11.78%) and a small amount of calcium (2.45%). Such a fluctuation in the mineral composition of phytin cannot but exert an influence on its biological properties.

In experimental samples obtained by modified methods the pattern improved appreciably. In phytin from heat-treated rice bran (sample 1) the amount of magnesium had fallen to 6.48% and that of calcium had increased to 10.30%. When at the stage of precipitating the technical product an additional amount of calcium ions was introduced by neutralizing the acid extract with calcium hydroxide (sample 2) and the precipitate is carefully washed, it was possible to achieve a reduction in the amount of magnesium to 3.85% and an increase in the amount of calcium to 9.59% and also a marked decrease in the amounts of sodium and potassium through the elimination of the water-soluble alkali-metal salts of the inositol hexaphosphates.

Thus, it is possible to conclude that the mineral composition of phytin may vary according to the nature of the plant raw material and also to the method of its production. The heat treatment of the initial raw material exerts an influence on the mineral composition of inositol hexaphosphate. By selecting the optimum conditions of performing the technological process we have obtained phytin with the necessary mineral composition from rice bran.

## EXPERIMENTAL

Calcium, magnesium, potassium, and sodium in the samples of phytin investigated were determined in the following way: an accurately weighed sample (~0.3 g) was placed in a 200 ml flask, 30 ml of $HNO_3$ (density 1.14 $g/cm^3$) was added, and this was evaporated at the boil to a volume of 5 ml. The residue was cooled slightly and after the addition of 10 ml of $HClO_4$ (density 1.68 $g/cm^3$) it was boiled until the solid matter had dissolved completely and white vapors appeared. The contents of the flask were again cooled and then, after the addition of 50 ml of double-distilled water, they were boiled for 10 min, after which they were transferred to a 200-ml measuring flask and made up to the mark with double-distilled water. The amounts of metal ions in the solution so obtained were determined, and samples of rice bran were subjected to ashing by known methods [9] and the amounts of metal ions were also determined in solutions of the ash.

The solutions were atomized in an acetylene–air flame, after being diluted with double-distilled water where necessary, and optical densities were determined.

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