

Review

Plant phosphates, phytate and pathological calcifications in chronic kidney disease[☆]

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ABSTRACT

Phytate, or myo-inositol 1,2,3,4,5,6-hexakis dihydrogen phosphate (InsP₆), is a naturally occurring phosphorus compound that is present in many foods, mainly legumes, whole grains and nuts. Patients with chronic kidney disease (CKD) have cardiovascular disease mortality up to 30 times higher than the general population. Vascular calcifications (VCs) directly contribute to overall morbidity and mortality, especially in CKD. In part, this high mortality is due to elevated levels of phosphorus in the blood. Therefore, control of dietary phosphorus is essential. Dietary phosphorus can be classified according to its structure in organic phosphorus (plant and animal) and inorganic (preservatives and additives). Plant-phosphorus (legumes and nuts), mainly associated with InsP₆, is less absorbable by the human gastrointestinal tract as the bioavailability of phosphorous from plant-derived foods is very low. Recent data indicate that restriction of foods containing plant phosphates may compromise the adequate supply of nutrients that have a beneficial effect in preventing cardiovascular events, such as InsP₆ or fibre found in legumes and nuts. Experimental studies in animals and observational studies in humans suggest that InsP₆ can prevent lithiasis and VCs and protect from osteoporosis. In conclusion, we need prospective studies to elucidate the potential benefits and risks of phytate (InsP₆) through the diet and as an intravenous drug in patients on haemodialysis.

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Fosfatos de origen vegetal, fitato y calcificaciones patológicas en la enfermedad renal crónica

RESUMEN

Palabras clave:

Enfermedad renal crónica
Hiperfosfatemia
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Ácido fitico
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Calcifilaxis

El fitato o *myo*-inositol-1,2,3,4,5,6-hexakis dihidrogenofostato (InsP₆) es un compuesto fosforado de origen natural que está presente en numerosos alimentos, principalmente en legumbres, cereales integrales y frutos secos. Los pacientes con enfermedad renal crónica (ERC) experimentan una mortalidad por enfermedad cardiovascular hasta 30 veces mayor que la población en general. Las calcificaciones vasculares (CV) contribuyen directamente en la morbitmortalidad general, y de forma especial en la ERC. Esta elevada mortalidad se debe, en parte, a la elevación en los niveles de fósforo en sangre. Por ello, el control de fósforo en la dieta es fundamental. El fósforo dietético puede clasificarse en función de su estructura en fósforo orgánico (origen vegetal y animal) e inorgánico (conservantes y aditivos). El fósforo de origen vegetal (legumbres y frutos secos), principalmente asociado a InsP₆, es menos absorbible por el tracto gastrointestinal humano siendo la biodisponibilidad del fósforo procedente de estos alimentos muy baja. Datos recientes indican que la restricción impuesta de alimentos que contienen fosfatos vegetales puede comprometer el aporte adecuado de nutrientes que tienen un efecto beneficioso en la prevención de episodios cardiovasculares, como pueda ser la fibra o al propio InsP₆ presente en frutos secos y legumbres. Estudios experimentales en animales y observacionales en humanos sugieren que el InsP₆ puede prevenir la litiasis, las CV y proteger de la osteoporosis. En conclusión, creemos necesario realizar estudios prospectivos para elucidar los posibles beneficios y riesgos de una dieta rica en fitato (InP₆) en la ERC o de su uso como fármaco intravenoso en pacientes en hemodiálisis.

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Introduction

Phytate or *myo*-inositol-1,2,3,4,5,6-hexakis dihydrogen phosphate (InsP₆) is the basis of phytic acid (Fig. 1). It is a natural component widely distributed in the plant kingdom. It serves as a store of phosphate and minerals and contains 75% of the total phosphate of seeds. The main source of InsP₆ is in whole grains, legumes, seeds and nuts. These

elements are very important for human consumption and constitute 40–60% of the calories ingested in developed and developing countries, respectively. In cereals, it is mainly located in the aleuronic layers and in legumes in the protein bodies of the endosperm or the cotyledon. During germination, InsP₆ is hydrolysed allowing the phosphate, magnesium and calcium to be available for the development of the plant. It is, therefore, the main source of plant phosphate. InsP₆ is predominantly present in unprocessed foods, as it can be degraded during processing and varying amounts of phosphate inositols may appear with less phosphates (*myo*-inositol pentaphosphate...).¹ Some of them, such as inositol triphosphate (DL-Ins_{1,4,5}P₃), are well-known intracellular messengers, which indicates the great importance that these compounds may have in human biology. The amount of InsP₆ that is consumed is very variable and depends on the type of diet. In the Western diet it may range from 0.3 to 2.6 g per day, and globally, from 0.180 to 4.569 g per day.² In developing countries and in exclusively vegetarian diets consumption can be very significant; on the other hand, in diets with predominance of “junk food” or with excess meat, typical of the Western diet, it is very poor.¹ The Mediterranean diet probably contains an intermediate amount of InsP₆ in the diet (1 g per day).³ During domestic handling of foods (cooked at about 100 °C) InsP₆ is quite stable. However, industrial manipulation, in which more extreme conditions are

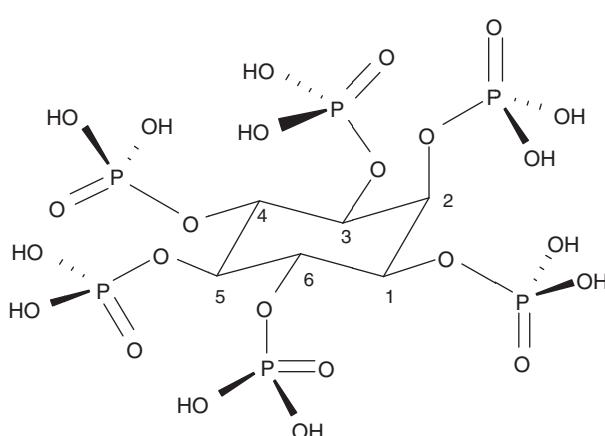


Fig. 1 – Structure of phytic acid (InsP₆).

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