Phosphates: Aren't they natural?

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Should phosphate be used as an ingredient in meat products?

There is no other ingredient, except for salt, which is as essential as phosphate in meat product applications. As important as phosphate is to functionality, it raises the question as to why there has been a push to remove phosphates as an ingredient over the last 10+ years? Phosphate is made up of 1 phosphorous atom and 4 oxygen atoms and has a negative charge. Phosphate and phosphorous are natural compounds found within our bodies, yet they are commonly replaced on clean label products. Why?

Phosphorous is an essential nutrient and is part of DNA, RNA, bones, and teeth. Muscles use adenosine triphosphate (ATP) to function, and phospholipids contribute to cell membrane flexibility. For the healthy general population, the only potential negative health issue with phosphates is that they are usually combined to sodium when used in foods which slightly increases the sodium content in the diet. The chemical structure of sodium tripolyphosphate, the most used phosphate in meat applications, is Na5P3O10 and has a molecular weight of 368 atomic mass units (amu). Sodium makes up 31.25 % of this molecule. If 100 g of meat are eaten with 0.5 % phosphate added, this is only approximately 0.15 g of sodium per 100 g serving of meat.

When does phosphate intake need to be controlled?

At present, there is not any scientific evidence that consuming phosphates is unhealthy for the general healthy population. However, there are two situations where phosphates, and more specifically phosphorous, intake should be regulated. When someone has kidney disease, consumption of excess phosphate will inhibit their kidney function. Phosphorous can also create problems when there is insufficient calcium in the diet since phosphorous and calcium work together. In most cases, phosphate adds more value to a meat product than its potential contribution to health problems. Does this indicate that it is time to reevaluate the use of phosphates in meat products?

Phosphates Improve Protein Functionality in Meat Applications

Phosphates are unique in that they improve the functionality of meat proteins. They improve water holding capacity, oxidative stability, texture, color stability and increase protein extraction **(Table 1)**. Phosphate chain length affects functionality **(Table 2)**, which is why different phosphate blends enhance functionality in specific product applications. Phosphates are like the Michael Jordan or Caitlin Clark of meat ingredients so why don't we want them on the food ingredient label?

Property	Mechanism
Antioxidant	• Tying up metal ions prevents their participation in oxidation reactions
Texture	• Contributes to improved tenderness
Protein Extraction	• Improves salt soluble protein extraction by adding ionic • Helps to relax and open up muscle protein structures to accept more water
pH	• Alkaline phosphate products increase pH and improve water • Many of these phosphates have pH ranges from 7.5 to 12.0 in 1% solutions and increase pH values of the muscle food system
Buffering Capacity	• Phosphates (especially monophosphates) add buffering capacity and therefore help the system resist changes when acids (or bases) are added to the system

Table1: Properties affected by phosphates in meat systems

Phosphate component	Chain Length (phosphorous units)	Primary Functions
Monophosphate (Orthophosphate)	One	• pH buffering
Diphosphate (Pyrophosphate)	Two	• Binds magnesium in water • extracts muscle proteins
Tripolyphosphate	Three	• Binds calcium
Polyphosphate (Tetra- or Hexametaphosphate)	Six or More	• Binds calcium • Improves solubility of the phosphate

Table 2. Properties of various phosphate components

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THE MEAT LOCKER
BY AMERICAN MEAT SCIENCE ASSOCIATION

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Replacing Phosphates in Meat Applications

Manufacturing clean label processed meats commonly includes removing phosphates from the product formulation and the ingredient label. This is challenging since phosphates provide many functions and cannot be replaced by any one ingredient. The best strategy for removing phosphate from a meat formulation is to substitute multiple ingredients that can provide acceptable functionality and product quality. It is important to understand that this approach of adding alternate ingredients will not achieve the functionality of phosphate.

Product Yileds (Cooking Loss, Purge Loss, Chill Loss)

Native potato starch, meat proteins (e.g., collagen, broth), milk proteins (e.g., whey protein concentrate), and vegetable fibers can all be used to bind and entrap water (both in the meat matrix and water in the formulation). These ingredients are sufficient in managing water, but they function differently than phosphates because they do not enhance the water holding capacity of the indigenous meat proteins. Alkaline phosphates increase pH, ionic strength, unfold proteins, and separate myosin from actin, all of which enhance the water holding capacity of the meat proteins. Potassium carbonate can be used as a processing aid to increase ionic strength, increase pH, and chelate metal in the water that is used in the brine or marinade. Antioxidant Rosemary, oregano, green tea, parsley, and cherry powder chelate metals, protect color, and prevent flavor oxidation. The active ingredients are ascorbic acid (cherry powder and parsley), catechins (green tea), rosmarinic acid (oregano), and carnosic acid (rosemary). Cilantro, onion, and garlic have also been added to products to chelate metals, prevent oxidation, and increase yields.

Texture

Phosphates provide enhanced protein extraction and binding properties that allow processors to thinly slice deli meat without tearing and contribute firm texture in deli and emulsion meat products. The same ingredients listed under the product yields section above contribute to the texture of products without phosphates. In addition, a mixture of iota and kappa carrageenan can be used to increase the firmness of meat product texture. Carrageenan is a key textural ingredient in deli meats, especially in products with no phosphate since it allows thin slicing due to the gel matrix formed by proper carrageenan application. Soy protein isolate also has gel properties for firm texture. Further, pea protein can be used to enhance texture and is gaining traction in non-meat imitation analogues.

Conclusions

A multiple ingredient approach is necessary to impart the functional characteristics of phosphates when it is replaced in processed meats where phosphates have been traditionally used. Phosphate functionality cannot be fully replaced since along with salt, it is one of the two key ingredients in whole muscle, deli, and emulsion-type processed meats with respect to yields and texture. In addition, there is not any scientific evidence that phosphate consumption is unhealthy for the general population.

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