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USE OF PHOSPHATES AND SALT TO IMPROVE LEAN MEAT WATER RETENTION IN HIGH-MOISTURE PREBLENDS

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BACKGROUND

Preblending involves grinding and mixing of separate meat ingredients with a portion of formulation salt, cure and water. With the increased use of water as a replacement for fat, the opportunity exists to utilize much higher than normal (≤20%) water levels in preblending systems. Swift and Sulzbacher (1963) found that the potential emulsifying capacity of beef is diminished when water is restricted. Kenney and Hunt (1990) showed that centrifugation losses declined as the water content of beef preblends was increased to 80%, providing that preblend ionic strength was maintained at the proper level. There has been minimal research on the effectiveness of high-moisture preblends and the use of phosphates in such a system.

OBJECTIVE

The objective of this research was to determine the effects of various phosphates and storage of preblends on functional improvement in high-moisture beef preblends.

METHODS

Preblends were formulated for use in a 15% fat/25% water added frankfurter, with 2.0% salt and 0.5% phosphate in the finished product, and an expected yield of 90%. Preblends included the following portions of the final formulation: all of the lean meat and an equal weight of water; half of the cure (0.25% meat weight; 6.25% sodium nitrite); all of the salt or a portion of the salt and all of the phosphate. Salt levels were reduced in the phosphate treatments on an iso-sodium ion activity basis. For each phosphate treatment and protein extracting solution, the amount of salt that could be replaced with phosphate and achieve the same Na^+ activity was 10% of the salt in the no-phosphate treatments. Beef Inside Rounds were completely denuded, ground though a 1.27 cm plate and then though a 3 mm plate. The lean beef was mixed by hand and a sample was drawn for proximate analysis.

Six treatments were manufactured in this study with a 1:1 ratio of lean beef and solutions (in distilled, deionized water) of the following ingredients: (1) no salt or phosphate (CONTROL); (2) salt (2.94%; all percentages are preblend weight basis) and no phosphate (NOPHOS); (3) salt (2.65%) and a neutral pyrophosphate (BK-PYRO3, .73%); (4) salt (2.65%) and sodium tripolyphosphate (BK-STP, .73%); (5) salt (2.65%) and a blend of sodium pyrophosphate and sodium polyphosphate (BK-414, .73%); or (6) salt (2.65%) and a blend of sodium tripolyphosphate and sodium hexametaphosphate (BK-512, .73%). All phosphates were provided courtesy of BK-Ladenburg, Gmbh, Ladenburg, Germany. Meat was added with solutions and mixed for 3 min on low speed in a kitchen mixer. After mixing, 7 samples (300 g each) were taken from each treatment, placed in plastic tubs and sealed with lids. These tubs were randomly assigned to seven time periods: 0, 4, 8, 12, 24, 36 and 48 h post manufacturing. Order of manufacture and order of testing at each time were randomized.

At each time period, triplicate samples (25 g) were stuffed into 50 ml centrifuge tubes for cooking stability, using a heating cycle similar to that of Townsend *et al.* (1968). Soluble protein extracting solutions were made up to match the salt and/or phosphate concentrations found in the aqueous phase of each treatment. The CONTROL preblends were homogenized in the same solution as the NOPHOS treatment. A "stirring" method of protein extraction was developed as suggested by Steinmann and Fischer (1993), in which a 3 g sample was mixed with 30 ml of solution for 2 min, using a stir bar and a magnetic stir plate. Duplicate samples (3 g) were taken at each time for orthophosphate analysis (Molins *et al.* 1985), using the modification of Li *et al.* (1993). This experiment was conducted as split-plot in time, and was replicated 3 times.

RESULTS AND DISCUSSION

Time did not effect soluble protein or pH, either as a main effect or an interaction ($P>0.05$). Particle size and amount of water in a preblend may dictate whether time will have a significant effect on soluble protein. The particle size used in the current study was small (3 mm) and level of water addition was 100%. Under these conditions, the initial mixing was enough to affect soluble protein. Table 1 shows the effect of preblend formulation on soluble protein and pH. Phosphate addition significantly increased the amount of soluble protein ($P<0.01$) over the NOPHOS and CONTROL treatments, a finding that is consistent with previous research (Knipe *et al.* 1990; Steinmann and Fischer 1993). Preblend pH (before dilution) was affected by phosphate and by salt addition ($P<0.01$; Table 1). The highest pH was noted with the more alkaline BK-STP (pH 8.8) and BK-512 (pH 8.3). Although BK-PYRO3 (pH 6.8) and BK-414 (pH 7.0) are neutral phosphates, the pH of these preblends was still higher than the NOPHOS and CONTROL treatments. These phosphates increased protein solubility to essentially the same extent, regardless of their impact upon pH.

Figure 1 shows the time x preblend interaction on cooking stability ($P<0.01$). All of the phosphate treatments provided a much higher degree of water retention during heating than the no NOPHOS and CONTROL, which is consistent with the soluble protein data. The much higher amount of soluble proteins in the phosphate treatments formed a heat-set gel that was able to entrap almost all (>90%) of the preblend weight. As with the soluble protein data, there were no major differences between the phosphates. The cooking stability of the NOPHOS preblend increased linearly with time. The lack of time effect on phosphate-containing preblends may not hold true when the volume of water in the preblend is reduced or the particle size is increased. Time did not affect orthophosphate in the NOPHOS and CONTROL treatments ($P>0.05$). All phosphate treatments increased in orthophosphate level with time (data not shown). With the exception of the BK-414 (orthophosphate leveled off at 36 hr) preblends, phosphate hydrolysis continued up to 48 h. For all of the phosphates, it appeared that their ability to affect muscle protein was maintained even though phosphate hydrolysis takes place, a finding that agrees with Hamm and Neraal (1977).

TABLE 1: PREBLEND EFFECTS ON SOLUBLE PROTEIN AND pH

	CONTROL	NOPHOS	BK-PYRO3	BK-STP	BK-414	BK-512	SEM
SOLUBLE PROTEIN, %	25.10[a]	26.56[b]	40.35[c]	38.90[d]	40.19[cd]	39.62[cd]	.45
pH	5.53[a]	5.49[b]	5.68[c]	5.96[d]	5.70[e]	5.90[f]	.01

Common superscripts within a variable denote non-significance, P>0.05.

CONCLUSIONS

Phosphate addition into high-moisture preblends provided a 15-20% increase in soluble protein levels and a 25-30% increase in cooking stability. Time in preblend tended to enhance the salt/no phosphate preblends, but did not influence phosphate containing preblends. These data offer fairly conclusive evidence that phosphates can be incorporated into meat preblends with no loss in protein solubility or water binding. The phosphates used did not differ in their ability to affect lean meat preblends, even though the neutral phosphates did not raise the preblend pH to the extent of the alkaline pH phosphates.

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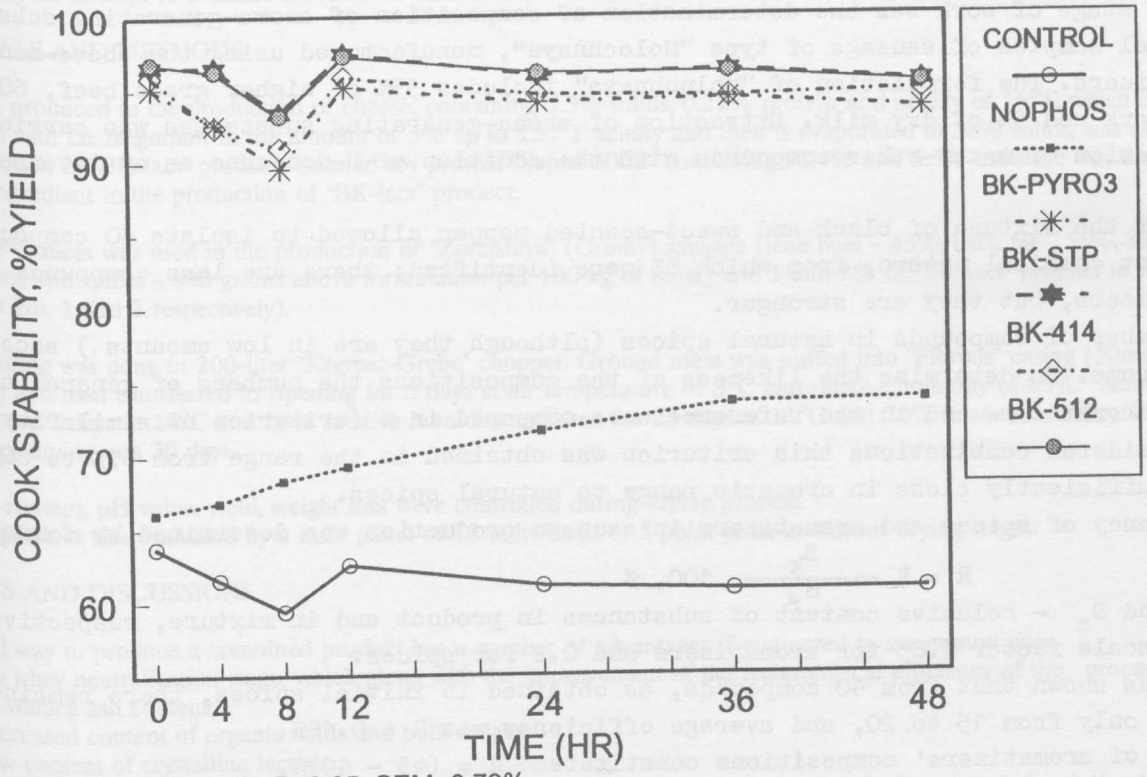
FIGURE 1: TIME X PREBLEND INTERACTION ON COOK STABILITY



TIME X PREBLEND, P<0.05, SEM=0.79%