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Technical Note

Specific Effect of Phosphate on the Functional Properties and Yield of Buffalo Meat Patties

ABSTRACT

Effects of pH and polyphosphate blends (PB) on the physico-chemical properties of buffalo meat and patties were studied. Minced buffalo meat was blended with 2% sodium chloride (NaCl) and the pH of the meat was increased with 0·5N sodium hydroxide (NaOH) to the pH of the meat containing 2% NaCl and 0·5% PB. Increasing the pH by NaOH incorporation significantly improved ($P < 0·01$) the water-holding capacity (WHC), emulsifying capacity (EC), emulsion stability (ES) and yield of patties and decreased ($P < 0·01$) cooking loss of meat and shrinkage of patties as compared to controls. Addition of PB improved ($P < 0·05$) EC, increased ($P < 0·01$) ES and yield of patties and reduced ($P < 0·01$) cooking loss and shrinkage of patties as compared to the NaOH-treated meat, which had higher ($P < 0·05$) WHC.

INTRODUCTION

Increasing meat pH above its isoelectric point significantly enhances the water-holding capacity (WHC), emulsifying capacity and protein solubility (Saffle & Galbreath, 1964; Froning & Neelakantan, 1971). Although sodium hydroxide (NaOH) has been approved for use in ham and bacon processing (Long *et al.*, 1982), limited information is available on the use of NaOH in processed meat (Knipe *et al.*, 1985*a*). Alkaline polyphosphates are widely used in meat formulations to improve the functional properties of meat, yield and palatability of the products (Keeton, 1983; Pearson & Tauber,

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1984; Kondaiah *et al.*, 1985; Knipe *et al.*, 1985*b*). Phosphates are known to improve WHC, particle–particle binding and the yield of the meat products, mainly due to their ability to increase ionic strength and the pH according to Trout and Schmidt (1984, 1987), who found the effect of pH and ionic strength to be cooperative. It is also not clear whether the beneficial effect of phosphate incorporation is primarily due to elevated pH and ionic strength or if phosphate has some specific effects. The objective of the present study was to determine the roles of pH (adjusted with NaOH) and phosphates on physico-chemical properties and yield of buffalo meat patties.

MATERIALS AND METHODS

Materials

About 2 kg meat (*Biceps femoris* muscle) from adult female buffalo carcasses of good finish was obtained within 5 h of slaughter. The sample was packed in a polyethylene bag and chilled at 2 ± 1°C for about 20 h. The meat was minced (passing through 8 mm followed by 4 mm plates) in a meat grinder. A similar meat sample was obtained in each trial of the experiment. Laboratory grade sodium chloride (NaCl), sodium hydroxide (NaOH) and phosphate blends (PB), consisting of 65% sodium pyrophosphate (SPP) (anhydrous), 17·5% sodium tripolyphosphate and 17·5% sodium acid pyrophosphate, were used (Anjaneyulu, 1988).

Analytical methods

The pH was recorded by directly placing the combination electrode of a pH meter into the finely minced meat. Salt-soluble proteins (SSP) and emulsifying capacity (EC) using refined soybean oil were determined by the methods of Knipe *et al.* (1985*b*) and Swift *et al.* (1961), respectively.

Water-holding capacity (WHC) was measured as per the procedure of Wardlaw *et al.* (1973) with slight modifications. To 30 g finely minced sample in a 250 ml polycarbonate centrifuge bottle, 45 ml of 0·6M NaCl was added, mixed with a glass rod and stirred for 2 min on a mechanical shaker. After holding for 15 min at 4°C in order to allow the effect of NaOH and phosphate to reach equilibrium, the meat slurry was again stirred for 1 min on a shaker and immediately centrifuged at 4°C and 5000 rpm for 15 min in a refrigerated centrifuge. The supernatant volume was measured. The amount of added solution retained by the meat was expressed as WHC in ml/100 g meat.

Cooking loss (CL) and emulsion stability (ES) were determined by

cooking the minced meat and emulsified samples (25 g), respectively, in polyethylene bags at 80°C in a thermostatically controlled water bath for 20 min. After draining out the exudate, they were cooled and weighed. The loss in weight was reported as percentage of CL. Stability of the meat emulsion was inversely related to its cooking loss. Diameters of raw and cooked patties were recorded with vernier calipers.

Experiment

Finely minced buffalo meat (250 g) was blended with 2% salt and the pH was increased by adding 0·5N NaOH to the same pH as that of the meat (250 g) containing 2% NaCl and 0·5% PB. An untreated sample was used as the control. Meat samples were evaluated for pH, WHC, SSP, EC and CL. Meat emulsions (300 g) were prepared with 85% fine minced lean meat and 15% refined soybean oil in a Hobart food mixer using wire whip at high speed, to which 2% NaCl (control) or 2% NaCl with 0·5% PB or 2% NaCl with 0·5N NaOH and 10% ice cold water were added while making the emulsion on the basis of meat and fat. The emulsion was moulded into three patties each weighing 80 g using a Petri dish (80 × 17 mm size). Patties were cooked to an internal temperature of 75°C in a preheated oven at 180°C for 20 min. The weights of cooked patties were recorded and cooking yield was expressed in percentage. Six trials were conducted and pooled data were statistically analysed (Snedecor & Cochran, 1968).

RESULTS AND DISCUSSION

Elevation of meat pH by addition of NaOH or phosphate significantly increased WHC, ES, EC and yield while reducing CL and shrinkage of patties (diameter) compared to untreated meat (Table 1). As the pH of the meat rises above its isoelectric point (5·4), WHC, EC and protein solubility are all reported to be increased (Saffle & Galbreath, 1964; Froning & Neelakantan, 1971; Knipe *et al.*, 1985*b*).

At similar pH values, meat containing NaOH had a significantly ($P < 0·05$) higher WHC compared to added phosphate, which might be due to the difference in ionic strength. Trout and Schmidt (1984) have shown that the WHC is enhanced with increasing ionic strength and pH until the total ionic strength is greater than 0·6 and pH of the uncooked product is greater than 6·0. The effects of pH and ionic strength were found to be cooperative in nature. Jauregui (1981) also attributed 80% of the SPP's effect on WHC to pH. Bendall (1954) reported a specific effect of sodium pyrophosphate compared to NaCl of corresponding ionic strength in increasing the swelling

TABLE 1
Effect of pH and Phosphate on the Quality of Buffalo Meat and Patties

Parameters	*Control*	*2% NaCl + 0·5% phosphate blend*	*Increased pH 2% NaCl + 0·5N NaOH*
pH	$5{\cdot}48 \pm 0{\cdot}01^a$	$5{\cdot}84 \pm 0{\cdot}02^b$	$5{\cdot}87 \pm 0{\cdot}03^b$
Water-holding capacity (ml/100 g)	$4{\cdot}02 \pm 0{\cdot}33^a$	$31{\cdot}92 \pm 2{\cdot}73^b$	$39{\cdot}72 \pm 2{\cdot}45^c$
Salt-soluble proteins (%)	$7{\cdot}71 \pm 0{\cdot}22$	$8{\cdot}41 \pm 0{\cdot}15$	$7{\cdot}82 \pm 0{\cdot}32$
Emulsifying capacity (ml oil/2·5 g)	$107{\cdot}30 \pm 5{\cdot}8^a$	$126{\cdot}50 \pm 4{\cdot}3^b$	$112{\cdot}30 \pm 5{\cdot}4^{ab}$
Cooking loss (%)	$40{\cdot}3 \pm 0{\cdot}7^a$	$20{\cdot}1 \pm 1{\cdot}4^b$	$25{\cdot}9 \pm 1{\cdot}6^c$
Emulsion stability (%)	$39{\cdot}2 \pm 0{\cdot}4^a$	$13{\cdot}9 \pm 0{\cdot}6^b$	$34{\cdot}9 \pm 0{\cdot}9^c$
Patties yield (%)	$57{\cdot}6 \pm 0{\cdot}5^a$	$91{\cdot}2 \pm 0{\cdot}3^b$	$64{\cdot}2 \pm 1{\cdot}3^c$
Shrinkage of patties (diameter) (%)	$22{\cdot}4 \pm 1{\cdot}0^a$	$7{\cdot}4 \pm 0{\cdot}4^b$	$17{\cdot}4 \pm 0{\cdot}5^c$

Means with same superscript in each row do not differ significantly ($P \leq 0{\cdot}05$).

of lean meat, possibly due to splitting of the contractile protein, actomyosin, into its components and partial conversion of them from gel into sol form.

Addition of phosphate resulted in significantly higher ($P < 0{\cdot}05$) EC, better ($P < 0{\cdot}01$) ES, and yield, lower ($P < 0{\cdot}01$) CL and less shrinkage (diameter) of patties as compared to that of meat with elevated pH by NaOH. Knipe *et al.* (1985*a*) reported that NaOH increased pH to a greater extent than SPP, but SPP enhanced ES more than NaOH. These authors concluded that increasing pH definitely had an effect on stabilising meat emulsions, but some other characteristics of SPP exerted an influence above and beyond that of the pH effect. Emulsion stability measures both water- and fat-holding capacities in actual meat emulsion systems and is considered a more reliable test. Pearson and Tauber (1984) reported that polyphosphates solubilise and dissociate actomyosin into actin and myosin which, in their dissociated form, can emulsify more fat. Kondaiah *et al.* (1985) have shown a specific effect of SPP on EC of buffalo meat and goat meat besides the effect through increased pH and WHC. Oord and Van den Wesdorp (1978) also observed the specific effect of pyrophosphate on protein solubility. Brotsky and Everson (1973) attributed the improvement in binding of sodium acid pyrophosphate to a specific phosphate effect or increased ionic strength which may be greater than the negative influence of reduced pH.

This study indicates that improved functional properties of meat and product yield were due to increases in pH and specific effects of

polyphosphate, over and above the effects of pH and ionic strength in meat systems. The performance of cooked patties was found to be improved more by polyphosphate addition than could be attributed to a simple increase in pH by NaOH addition.

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