STUDIES ON CHEMICAL AND ORGANOLEPTIC PROPERTIES OF DEHYDRATED FORMED BEEF

S. O KEMBI and A. J. OLORUNKOYA
Department of Animal Production
Ogun State University, Ago-Iwoye
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ABSTRACT
Product yield, chemical properties, rehydratability and organoleptic characteristics were studied in dehydrated blends of raw beef muscle and connective tissue minces untreated or pre-treated with either 1.0 percent sodium chloride (NaCl), 0.3 percent sodium tripolyphosphate (STPP) or a combination of 0.7 percent NaCl plus 0.3 percent STPP. Sodium chloride and tripolyphosphate either individually or combined significantly ($P < 0.05$) increased product yield, moisture and ash contents, improved flavour and acceptability but depressed tenderness and rehydratability of dehydrated formed beef steaks. The additives slightly reduced protein and fat contents but raised the pH; these effects were however not significant ($P > 0.05$). The combination of NaCl and STPP was found in most cases to impart the greatest effect on parameters measured. Based on the results, it was concluded that the products would be suitable for local systems of meat usage without fear of possible disintergration.

Key words: Dehydrated formed beef, meat properties, sodium chloride, tripolyphosphate.

INTRODUCTION

The concept of restructured technology in meat products has not been widely used in Nigeria. Restructuring of meat involves the utilization of a reasonable range of meat pieces which will be bound together and shapen to form larger pieces of meat or steaks having accurate and predictable shape and characteristics. With the economic situation in the country, it is believed that restructuring technology may serve to reduce the wasted edible portions of slaughtered animals. This is apparently due to the possibility of incorporating such low value meat trimmings and tougher cuts of meat to get a more tender and highly valued product. In this way meat cuts of lower economic value can be transformed into uniform products which would provide greater variety and increased convenience for consumers.

Drying of meat with or without salt or smoking are widely accepted traditional methods of preserving meat in Nigeria. Drying is probably the least expensive and adaptable to most parts of the world. Although the terms "drying and dehydration" are used synonymously, drying usually refers to sun-drying whereas dehydration refers to drying under controlled conditions of temperature and airflow (Gailani and Fung, 1986). Dried foods are less costly to produce, require minimal labour input, limited processing equipment, no refridgeration and the distribution costs are reduced (Desrosier,1963). Dried or dehydrated foods are more concentrated than any other form of preserved foods. The chemical composition of dehydrated meat is a matter of basic importance and the proportions of protein, fat and ash have broad meaning in relation to quality and nutritive value (Hankins *et. al.*, 1946). For restructured meat systems there is the added concern about textual stability. Ibrahim *et. al.* (1985) have demonstrated the shelf stability of dehydrated beef patties stored at 25°C following treatment with sodium chloride and potassium sorbate.

The present study investigates the chemical and orgnanoleptic qualities as well as rehydratability of formed dehydrated beef steaks and how such properties are influenced by the incorporation of Sodium chloride and Sodium tripolyphosphate.

MATERIALS AND METHODS

Meat

The raw meat used in this study were the entire thigh muscles of matured cows purchased from a local abattoir. All bones, connective tissues and surface fats were separated. The resulting chunks of meat were tempered for 24 hours at -18^{0}C and more fat and connective tissues were removed. Both the muscles and the connective tissues were minced separately in a Kenwood chef kitchen mincer with 8mm plate. Each of the materials were thoroughly mixed and packed separately for storage. The muscle-mince was packed into four lots of 4kg each and the connective tissue-mince was also divided into four portions. All materials were stored at -18^{O}C.

Additives

Additives used were sodium chloride (NaCl) and sodium tripolyphosphate (STPP) courtesy FMC Philadelphia U.S.A. The concentration of NaCl and STPP based on the weight of raw blend of muscles and connective tissue minces were: 1.0 percent NaCl, 0.3 percent STPP, combined 0.7 percent NaCl plus 0.3 percent STPP and a control without additives.

Preparation of Dehydrated Formed Steaks

Dehydrated steaks were prepared by first mixing together one lot each of beef and connective tissue minces at 3.6kg beef and 0.4kg connective tissue after thawing overnight in a refridgerator (8-12^{0}C). The mixture was divided into four portions, each portions being alloted to one of the four treatment of additives. The salt additives were added to the portions (except the control) with the amount of additives being determined by the levels of additives and weight of raw mince. The mixture was thoroughly mixed for 5-7 minutes then moulded into 50g steaks having 5cm diameter and 2.5cm depth. The steaks were dehydrated at 57-62^{0}C in a forced-air oven for 30 hours. The dried steaks were kept in air tight cans and stored at -18^{0}C for evaluation. The preparation and drying processes were repeated four times.

Analytical Methods

Yield of the dehydrated steaks was determined by the percentage ratio of the dry steaks weight to the wet steak weight with 20 steaks per replicate. Proximate composition (crude protein, fat, moisture and ash) and pH were determined (AOAC, 1975) in duplicate for each replicate. A trial run on rehydration at room temperature was carried out using the control samples soaked in five times their weight of distilled water. Rehydratability of the soaked meat was monitored after one, two, five and twenty four hour periods. Rehydration at elevated temperatures was carried out by employing two methods: 15 minutes boiling followed by 45 minutes soaking in the boiled water (METHOD I) and soaking in hot freshly boiled water for 45 minutes followed by 15 minutes of boiling (METHOD II). In both methods no particular constant soaking temperature was maintained and the meat samples were rehydrated in five times their weight of water in covered containers. All processes were replicated four times with four steaks per replicate. Rehydratability was expressed as gm H_20 per 100gm meat using the formular

$$\frac{100\,(HW-DW)}{DW}$$

where HW = hydrated weight and DW = dehydrated weight of the restructured beef steaks.

Organoleptic experiments tested for flavour, tenderness, juiciness and overall acceptability of cooked rehydrated steaks. Ten untrained panelists were asked to evaluate the parameters on a nine point hedonic scale from 1 for extremely undesirable (flavour), extremely tough (texture), extremely dry (juiciness) and dislike extremely (overall acceptability) to 9 for extremely desirable (flavour), extremely tender (texture), extremely juicy (juiciness) and like extremely (overall acceptability). The panelists met eight times to evaluate the four replicated steak preparations. All data were statistically analysed for significance (Steel and Torrie 1960) and treatment means were separated with Duncan's (1955) multiple range test.

RESULTS

Proximate composition and pH of the raw mixed mince are shown in Table 1. The yield, pH and proximate composition of rehydrated restructured steaks are shown in Table 2. Generally, samples with additives showed significantly

($P < 0.05$) higher yields than the control. Samples with NaCl and STPP in combination had the highest yield, which was, however, not significantly different from samples with NaCl alone. Samples without additives had higher levels of protein and fat contents compared to treated samples (Table 2). These differences were, however, insignificant. Samples with STPP had higher pH values in absolute terms but were not significantly different ($P > 0.05$) from untreated samples or those with NaCl alone. Generally the preparation and dehydration processes increased the pH values of beef in this study (Tables 1 and 2).

TABLE 1. PROXIMATE COMPOSITION (AND STANDARD ERROR) OF THE RAW BLEND OF BEEF AND CONNECTIVE TISSUE MINCES UTILIZED IN THE PRODUCTION OF THE FORMED STEAKS

Protein content (g/100g meat)	20.58 ± 1.13
Fat content (g/100g meat)	3.57 ± 1.07
Ash (g/100g meat)	1.26 ± 0.39
Moisture (g/100g meat)	73.51 ± 1.94
pH	5.80 ± 0.38

TABLE 2. YIELD AND PROXIMATE COMPOSITION OF DEHYDRATED FORMED BEEF STEAKS.

Parameters	ADDITIVES				
	Control	NaCl	STPP	STPP + NaCl	SE
Yield %	28.21c	31.59ab	30.37b	32.73a	0.417
Moisture(g/100g meat)	19.12c	21.33ab	20.54bc	22.64bc	0.618
Protein content(g/100g meat)	81.06	79.24	80.29	79.35	0.809NS
Fat content(g/100g meat)	13.15	12.88	13.02	12.09	0.504NS
Ash (g/100g meat)	4.68c	7.28	5.88b	7.04a	0.345
pH	7.18	7.15	7.43	7.35	0.182NS

Figures in the same row bearing similar subscript are not significantly different ($P < 0.05$) NS = not significant.

Figure 1 shows the rehydratability of the control beef steaks at room temperature. Rehydration of these samples was found to be a very slow process with rehydratability values of 10.24gm H_2O/100g meat after one hour of soaking. A 24 hour period of soaking however resulted in an appreciably high (53.87gm H_2O/100gm meat) rehydratability value. The two methods of rehydration at elevated temperature significantly increased the amount of water absorbed by the dehydrated steaks with method I being superior to method II (Figure 2). The presence of additives on dehydrated streaks drastically reduced the amount of water absorbed, the effect being more pronounced in samples with NaCl. The significant interaction ($P < 0.05$) between the rehydration methods and additives was such that rehydratability values between the rehydration methods were not significantly different in samples treated with STPP whereas large differences occurred in both the control and NaCl treated samples.

Samples used for organoleptic evaluation of the restructured beef steaks were prepared using the rehydration method I. Panelists rated samples with NaCl significantly higher than those without for both flavour and overall acceptability. Slight but insignificant differences were found among all samples for juiciness with samples containing NaCl being slightly less juicy. Rehydrated steaks with NaCl + STPP combination were found to be the toughest in texture and were statistically different from all others. Other samples were however not found to be texturally different

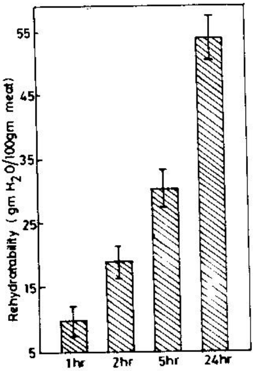

Fig. 1: Mean value (and standard error) of rehydrability of the control formed beaf steak soaked in cold water for varying periods.

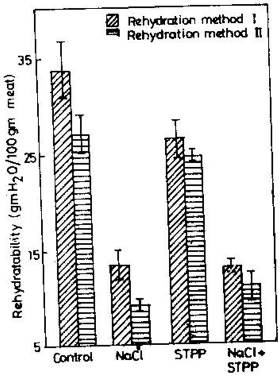

Fig. 2: Mean value (and standard error) of rehydrability of formed beaf steak as influenced by additive x rehydrated method interaction.

TABLE 3: ORGANOLEPTIC EVALUATION OF THE DEHYDRATED FORMED BEEF STEAKS

		ADDITIVES			
Palatability traits	Control	NaCl	STPP	STPP + NaCl	SE
Flavour	4.00b	7.20a	4.80b	7.70a	0.352
Tenderness	5.13a	4.23ab	4.93a	3.43b	0.361
Juiciness	4.90	4.20	5.00	4.43	0.272NS
Acceptability	3.73b	6.23a	3.70b	6.58a	0.232

Figures in the same row bearing similar subscript are not significantly different ($P < 0.05$) NS = not significant.

(Table 3). Flavour and texture appear to have very strong influence on overall acceptaility of dehydrated restructured beef.

DISCUSSION

Dehydrated restructured beef resulted in a solid integrated body mass which was enhanced by the presence of sodium chloride and tripolyphosphate. These mineral additives have been implicated in reducing the effects of those factors that are responsible for the exudation of fluid meat, thereby reducing thaw drips in thawed frozen meat (Bohn and Conic, 1976) and reducing shrinkage of lean intact meat (Werbicki *et al* 1976) and ground meat (Kembi and Okubanjo 1989). Phosphates also increase pH and in the presence of sodium chloride are known to enhance dissociation of actomyosin, thus making it more soluble (Trout and Schmidt, 1984). The protein so extracted serves as natural cement for binding particles of restructured meat together. On heating and drying, extracted protein within and at the surface of the formed meat may coagulate to further bind more water within the meat. Furthermore the effect of polyphosphate on myofibrilar proteins in the presence of sodium chloride is an irreversible dissociation of actomyosin, a phenomenon that has been shown to be heat stable (Shultz *et al*, 1972). The trends for the product yield and tripolyphosphate either individually or when combined enhance moisture retention in spite of long period of heat treatment and consequently increase product yield and moisture content. The values of other nutrients such as protein and fat will be dependent on the amount of residual moisture and possibly the ash content. The ash content is in itself a reflection of the amount of the additives used.

The extracted protein coagulated on the surface of the dried steaks resulting in case-hardening during drying. Furthermore, the reduction in surface area: a result of shrinkage and binding force between the meat particles, resulted in increased surface fat. Fat is known to hinder water absorption in dehydrated meat (Hankins and Hetzer 1947). Similarly the binding force produced by the cementitious exudates is apt to prevent free movement of water into the meat thereby resulting in poor rehydratability. The greater moisture absorption resulting from cooking prior to soaking than with soaking prior to cooking may be explained by the fact that moisture and heat constitute the softening force enhancing moisture inflow during subsequent soaking. However, there was not much of a force to dreive the water into the meat during initial soaking in method II. Rapid softening of the meat was achieved during boiling. Method II did not allow the softened steaks to stay in water long enough to effect proper absorption. The hot water soaking as compared to cold water serves to melt the surface fat thus exposing the meat surface for water absorption.

Sodium chloride and tripolyphosphate serve as curing agents and sodium chloride in addition imparts flavour to meat and therefore renders the products more desirable to consumers. The inability to detect differences in juiciness by the taste panel despite the large differences in rehydratability may be attributed to the rather low moisture in the meat samples even after rehydration. Since juiciness depicts the amount of expressible juice during mastication, it will require certain minimal moisture level in a meat system above which appreciable juice can be expressed. It is most likely that such minimal or threshold level was not attained by any of the rehydrated samples. The contributions of the additives to the binding force in formed meat systems explains the thoughness of the dried steaks as perceived by the panelists. Lamkey *et al* (1986) have indicated that greater force may be required to break such materials. The toughest of the materials were the ones the panelists fond most acceptable. This may indicate that either the panelists were trading texture for flavour or the texture was considered acceptable. The latter reasons is supported by the findings of Okubanjo (1988) who noted that tenderness was singularly the most important factor determing acceptability of meat, this is followed in importance by flavour and juiciness.

No attempt has been made to evaluate the shelf stability of the dehydrated restructured beef in this study. Worthy of note, however, are its acceptability by consumers and textural stability. When cooked, no cook-outs were observed except for some fat on the surface of the boiling water. It may therfore be concluded that these products will be suitable for our local system of meat usage without fear of possible disintegration.

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