EFFECTS OF MAJOR INGREDIENTS ON QUALITIES OF A LOW-FAT EMULSIFIED MEATBALL

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ABSTRACT

A four-factor central composite design was adopted for studying the effects of phosphates, water, fat and salt on organoleptic qualities of a low-fat emulsified meatball (Chinese meatball). Results indicated that higher salt addition caused more salt soluble protein to be extracted from the muscle cells to form a more stable meat emulsion, which made the final product harder and, therefore, obtained higher preference scores from the panels. Higher fat addition produced lighter products, but product color has a minor influence on its acceptability. Products' texture was significantly affected by interactions of phosphates with salt and maximum texture score in the tested ranges appeared at 2.4% salt addition level and 0.5% phosphate addition level. Treatment combinations with less water, more fat, more salt and more phosphate additions yielded better preference and better acceptance samples.

INTRODUCTION

Emulsified meatball or Chinese meatball, called 'Kung-wan' in Taiwanese, is a very popular meat product in Taiwan and related Chinese communities. It is different from western style meatballs in its processing methods and product properties. Western meatballs usually are made of different kinds of minced meat such as pork, beef, etc. Its texture is soft because binding between ingredients is loose. Chinese meatballs are normally made by grinding swine muscle tissues, fat and salt with a cutter, meat pounder or stone grinder. Therefore, it is an emulsified meat product and its texture is much tougher. In a previous report (Hsu and Chung, 1998), we studied total effects and cross-factor interactions of major processing factors, including salt、fat、sugar and cooking temperature on qualities of Kung-wan products.

Although Kung-wan is very popular. It is becoming a health concern for consumers because of its high lipid content of greater than 30% of its total weight. Therefore, as part of a series of studies in developing low-fat Kung-wans, water is used to replace some fat ingredient in this study and phosphates were adopted to improve qualities of the low-fat products. The purpose of this study is to investigate the total effects and cross-factor interaction effects of the additions of water、phosphates、salt and fat on organoleptic qualities of the low-fat Kung-wan products.

MATERIALS & METHODS

Swine of 90 to 100 kg body weights were used for the study. Leg muscle tissues and back fat of the swine were purchased from a local meat packer. The swine were slaughtered and cooled in a -10 ℃ cold room for one day before being cut and shipped to the pilot plant. The tissues were mixed and ground with a meat chopper fitted with a plate of 15-mm diameter holes. The ground meat was packaged in double plastic (PE) bags, 0.5 kg each, and stored at -20 ℃ until used within two months.

The Chinese style meatballs or Kung-wans were manufactured according to the same processing scheme as before (Hsu and Chung, 1998). Four major processing variables were investigated in this study. These were: the amount of back fat (as % of lean muscle tissues), of salt (% NaCl), of water (% water) and of phosphates (% of phosphate, which is consisting of sodium polyphosphate and sodium pyrophosphate, 50/50, w/w, Kamino Chem. Co. Inc., Osaka, Japan) additions during grinding. The ranges of each variable explored in this study are shown in Table 1. The maximum concentration of phosphate permitted in the finished meat product is 0.5% in the United States (Sofos, 1986). A four-factor central composite design (Joglekar and May, 1987; Myers, 1971) was adopted for the study. All treatment combinations were randomly assigned to different meat samples. Five equally spaced center-points were replicated for measuring the random errors. Total number of specimens was 29. SAS (SAS, 1988) and SPSS (SPSS, 1984) statistical packages were used for all statistical analyses.

The color、odor、taste、texture and overall acceptance of each sample specimen was judged by 7 test panels based on a five-point hedonic scale. A higher average score signifies better preference. Average of the 7 measurements was taken for each preference score datum.

RESULTS & DISCUSSION

All quality data were fitted with quadratic linear regression models. Results of analysis of variance (ANOVA) showed that variations due to the lack-of-fit terms of the models were insignificant (Table 2). This indicated that most variations could be well explained by the quadratic models.

Preference scores given by the panels (Table 2) showed that some of the Kung-wan samples made in this study were unacceptable in their organoleptic qualities. Contour plots of the overall acceptance scores verses processing factors indicated that some treatment combinations in the tested ranges were not suitable for making Kung-wan products (acceptance < 3.0). Most effects of fat and of salt additions on these panel test indices were similar to the previous report (Hsu and Chung, 1998). Namely, higher salt addition caused more salt soluble protein to be extracted from the muscle cells to form a more stable meat emulsion, which made the final product harder and, therefore, obtained higher preference scores from the panels. Higher fat addition produced lighter products, but product color has a minor influence on its acceptability. Increase in phosphate and salt addition levels significantly increased most quality preference scores of the products (Table 2). Texture scores also increased with less added-water. It has been reported (Hsu and Chung, 1998) that texture is the most important property of kung-wans and consumers prefer a harder texture. Results also showed that interaction effects on product texture were significant (Table 2). Further analyses showed that products' texture was significantly ($p < 0.01$) affected by interactions of phosphates with salt (Table 3). Maximum texture score in the tested ranges appeared at 2.4% salt addition level and 0.5% phosphate addition level, which approximately coincided with the maximal acceptance score.

Correlation coefficients between each quality indices indicated that texture is the most important factor in deciding overall acceptance of the Kung-wan products while color has a minor influence on product acceptability (r= 0.926 and 0.658, respectively).

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Table 1. Testing ranges of processing variables explored in this study

Ranges	Fat (%)	Salt (%)	Water (%)	Phosphates (%)
Low	0	1.0	10	0.00
High	10	3.0	30	0.50

Table 2. Ranges of experimental data and significance of the regression models and of the effects of processing factors on organoleptic quality indices of low-fat Kung-wans

Source	Color	Odor	Taste	Texture	Acceptance
Linear	★★	★★	★★	★★	★★
Quadratic	–	–	–	–	–
Cross-product	–	–	–	★	–
Total regress	★	★	★★	★★	★★
Lack of fit	–	–	–	–	–
Total effect of:					
Fat	–	–	–	★	–
Salt	–	★★	★★	★★	★★
Water	–	–	–	★★	–
Phosphates	★	★	★	★★	★★
Ranges	2.4 ~ 4.4	1.7 ~ 4.4	1.8 ~ 4.4	1.3 ~ 4.6	1.6 ~ 4.1

Significance: ★ 0.05, ★★ 0.01

Table 3. Significance of two-factor models on texture of low-fat Kung-wans

Source	Texture	
	Model	Lack of fit
Phosphates * Salt	★★	–
Phosphates * Water	★★	★
Phosphates * Fat	–	–
Salt * Water	★★	★
Salt *Fat	–	–
Water *Fat	–	–

Significance: ★ 0.05, ★★ 0.01.

NOTES

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