STUDIES ON DEVELOPING LOW FAT EMULSIFIED MEATBALLS

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Background.

Emulsified meatball, containing 25-30% lipid, is a popular meat product in Taiwan and related Chinese communities. Edible gum-hydrates were proposed to replace pork fat in making low-fat emulsified meatballs.

Objectives.

Many edible gum-hydrates could be used to make low fat emulsified meatballs. The objective of this study is to find the best fat substitute and the best processing conditions.

Methods.

A four-step approach was proposed to solve the problem as following:

(1). **Studying quality characteristics of emulsified meatballs.** Two four-factor central composite designs were adopted for studying the effects of processing factors on qualities of emulsified meatballs and of low fat emulsified meatballs. The quality characteristics of emulsified meatballs were defined from the results.

(2). **Screening for better fat substitutes from possible low fat formula.** Two one-way completely randomized designs were adopted for comparing 16 emulsified meatballs and for comparing reheated emulsified meatballs. Four fat substitutes were chosen for further studying based on the results.

(3). **Investigating interaction effects among the chosen fat substitutes.** A four-factor rotatable central composite design was adopted for studying possible synergistic effects of the four chosen fat substitutes.

(4). **Optimizing the processing system with the chosen fat substitute.** A four-factor central composite design was adopted for studying the effects of four processing factors on qualities of low fat emulsified meatballs. The best formula was derived from the results.

Results and discussions.

Results obtained in each step of the proposed approach for developing low fat emulsified meatballs were summarized as following:

(1). **Studying quality characteristics of emulsified meatballs.**

Results (Hsu and Chung, 1998) indicated that heating at 80 ℃ for 20 minutes was the best cooking conditions and texture was the most important characteristic of this type of products. Consumers prefer harder textures. Preferences of a sensory panel significantly increased with the amount of salt added and decreased with the amount of fat added in the product. Another results (Hsu and Yu, 1999) indicated that treatment combinations with less water, more fat, more salt and more phosphates additions yielded better preference and better acceptance products. Adding more than 2.2% of salt and less than 22% of water produced acceptable low-fat meatballs.

(2). **Screening for better fat substitutes from possible low fat formula.**

Results (Hsu and Chung, 1999) indicated that κ-carrageenan, sodium alginate with $CaCO_3$, curdlan gum and locust bean gum, appeared to be good fat substitutes for making low fat emulsified meatballs. Another results (Hsu and Chung, 2000a) indicated that κ-carrageenan, sodium alginate with CaCO3, agar and KonOH resulted in low fat products with better reheating qualities. Four gum-hydrates; konjac premixed with $Ca(OH)_2$ (KonOH), agar, curdlan gum and κ-carrageenan were chosen from the previous step for further study.

(3). **Investigating interaction effects among the chosen fat substitutes.**

Results (Hsu and Chung, 2000b) indicated that there was no significant interaction among the four gum-hydrates in the testing ranges for the testing quality indices.

(4). **Optimizing the processing system with the chosen fat substitute.**

It was concluded from the previous step that κ-carrageenan appeared to be the best fat substitute among the 13 different edible gum-hydrates and it did not have significant interaction with the other gum-hydrates. A four-factor central composite design was adopted for studying the effects of κ-carrageenan, fat, salt and phosphates on qualities of low fat emulsified meatballs. Quadratic regression model for each quality indices was derived from the data. An optimization problem was formulated for each sensory quality indices by using their regressed quadratic model as an objective function and their testing ranges as constraints. Optimal processing conditions for each sensory quality indices were then calculated by solving the optimization problem. Results were shown in Table 1. It is noted that the quadratic model of color was insufficient to explain the variations due to significant lack-of-fit. Since color and odor of the products were less important and were more easily modified by adding other spices, it is concluded that addition levels of fat, salt, polyphosphates and κ-carrageenan at around 0%, 2.7%, 0.17% and 2%, respectively, will produce the most acceptable product.

Conclusions.

k-Carrageenan is the best fat-substitute for making low fat emulsified meatballs. Heating at 80 ℃ for 20 minutes is the best cooking conditions. Simmering at 80 ℃ for 15 minutes is the best reheating conditions. Addition levels of sugar, fat, salt, polyphosphates and κ-carrageenan at around 3%, 0%, 2.7%, 0.17% and 2%, respectively, produced the most acceptable product.

The final processing scheme is following: Pig leg muscle tissues ground with a 0.5 cm-hole meat chopper ---> ground with 2.7% salt, 3% sugar, 0.17% polyphosphates and 2% k-carrageenan in an ice-cooled stone grinder for 20 minutes. ---> shaped into 3 cm-diameter meatballs ---> cooked in 80 ℃ hot water for 20 minutes -> cooled to room temperature with tap water ---> final products. The products can be packaged in laminated film (Nylon/PE) bags and frozen. When served in hot soup, simmering for 15 minutes is the best reheating method.

Pertinent literatures.

Hsu, S.Y. & Chung, H. -Y. (1998). Effects of processing factors on qualities of emulsified meatball. Journal of Food Engineering, 36(3), 337-347.

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Table 1

Predicted optimal processing conditions for different sensory quality indices of low fat emulsified meatballs made of κ -carrageenan [a]

Factors	Color [b]	Odor	Taste	Texture	Acceptance
Fat (%)	0	10	0	0	0
Salt (%)	1.5	2.1	2.8	2.7	2.8
Polyphosphates (%)	0.40	0.40	0.17	0.15	0.15
κ -Carrageenan (%)	2	0	2	2	2
Maximal value	4.7	4.5	4.4	5.6	4.8
Fat Control [c]	3.6	3.6	3.5	4.5	4.3

[a] Calculated values based on regressed quadratic models.

[b] Lack-of-fit term of the quadratic model was significant.

[c] 20 % fat addition and no κ -carrageenan addition.