PHYSICOCHEMICAL CHARACTERISTICS OF CHINESE MEATBALLS WITH MECHANICALLY DEBONED BULLFROG MEAT ADDED

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Introduction

Mechanical deboning is removal of soft tissue from animal or poultry bone frames, which are meat processing by-products, with low commercial values, but still contain many useful and nutritional materials. The mechanical deboner produces a batter-type material which can be further utilized in food manufacturing. This increases the utilization and values of these byproducts (Hedrick *et al.*, 1994). Use of mechanically deboned meat in many products has been well documented (Thomsen and Zeuthen, 1988; Mielnik *et al.*, 2002; Daros *et al.*, 2005). Bullfrog (*Rana catesbeiana*) is a popular food material in Taiwan. Bullfrog legs are the only consumed parts; the other parts are dumped or used for animal feed. How to make good use of this animal byproduct and produce high quality Chinese meatballs, a very popular meat product in Taiwan and many other areas has become of interest to meat industries. The objective of this study was to evaluate the physicochemical qualities of Chinese meatballs containing various amounts of mechanically deboned bullfrog meat (MDBM) when the product was stored under refrigeration.

Materials and Methods

Raw delegged bullfrogs (*Rana catesbeiana*) were obtained from a local frog raising farm in Pingtung, Taiwan, mechanically deboned through a deboner to obtain mechanically deboned bullfrog meat (MDBM), and stored at -20ºC prior to manufacturing meatballs. Fresh pork leg and pork back fat were ground utilizing a 3 mm plate. Meatball samples were formulated with 25% fat. For the samples with MDBM added, 7.5, 15, 22.5 or 30% MDBM were first mixed with ground pork, salt (1.8%) and phosphate (0.2%) for 3 min, then the fat (25%) and other non-meat ingredients including 3.5% sugar, 2.0% potato flour, 1.0% MSG, 0.3% white pepper powder, and 0.05% sodium erythorbate were added, and mixed thoroughly for approximately another 4 min. Then, the meat mixtures were manually formed into meatballs with approximate average weight of 15-25 g, cooked in a water bath at 75ºC until the internal temperature of meatballs reached 70ºC for 20 min, cooled in a ice bath for 10 min, dried at room temp for 10 min, packed in plastic bags, stored at 7ºC for 14 days, and analyzed at day 0, 7 and 14. Moisture and ash contents were measured according to the AOAC (1980) method. Crude fat was measured using a fat extractor. Crude protein was measured using the Kjeldahl method. Water holding capacity was measured according to the Dagbjartsson and Solberg (1972) method. The L*, a*, and b* values, pH, cooking loss of samples were measured. TBA values of the samples were determined according to the methods described by Salih *et al.* (1987). Data was analyzed using the SAS software.

Results and Discussion

The results showed that meatballs that had more MDBM added tended to have higher moisture, and lower protein and fat contents (Table 1). Also, adding more MDBM resulted in a significantly lower L* colour values in the samples which indicated a darker colour while there were no significant differences in the a* and b* colour values among the samples. Adding more MDBM resulted in a significantly ($p < 0.05$) lower water holding capacity in the samples (Table 2) and adding more than 22.5% resulted in significantly ($p < 0.05$) lower water holding capacity. This reduction of water holding capacity of the product was probably because the MDBM texture was partially destroyed during mechanical separation and processing, thus resulting in less functionality of the raw materials. Adding more MDBM during manufacturing tended to increase the cooking loss of the meatballs (Table 2). For example, samples that had 30% MDBM added had significantly ($p < 0.05$) higher cooking loss of 7.11% when compared to samples that had 0 to 15% MDBM which resulted in losses between 4.27 to 4.70%. Higher cooking loss probably resulted from the lower water holding capacity which resulted in higher weight losses of the samples, and probably would result in less juiciness and tenderness of the products. This increase of cooking loss may also be due to the samples that had more MDBM added which resulted in more destroyed texture material, and lower water holding capacity. However, adding MDBM up to 15% did not significantly affect the cooking losses of the samples. The data showed that the pH values of Chinese meatballs decreased when stored under refrigeration for 14 days (Table 3). In addition, adding more MDBM during manufacturing resulted in a significantly ($p < 0.05$) higher pH value of the products during 14 days of refrigerated storage. As expected, the TBA values of Chinese meatball samples increased with storage time, indicating that lipid oxidation had occurred in the meatball samples during refrigerated storage. The data also indicated that the samples with no MDBM added had significantly ($p < 0.05$) lower TBA values than the samples with MDBM added. In addition, samples that had 7.5 and 15 % MDBM added had significantly ($p < 0.05$) lower TBA values than those with 22.5 or 30 % MDBM added during the refrigerated storage. This result indicated adding MDBM up to 22.5 and 30% might result in a higher lipid oxidation which was undesirable.

Table 1: Proximate composition and colour values of Chinese meatballs with various amounts of mechanically deboned bullfrog meat (MDBM) added.

Items	Mechanically deboned bullfrog meat added (%) 0	7.5	15.0	22.5	30.0
Moisture	59.95±0.75^{w}	60.61±0.74^{wx}	61.03±0.80^{xy}	61.43±0.69^{xy}	62.43±1.24^{y}
Protein	24.07±0.46^{w}	23.76±0.35^{wx}	23.39±0.69^{x}	22.56±0.36^{y}	21.87±0.20^{z}
Fat	17.22±0.88^{w}	15.44±0.29^{x}	15.04±0.26^{x}	14.23±0.14^{y}	14.16±0.04^{y}
Ash	2.40±0.45	2.03±0.97	1.99±0.46	1.93±0.46	1.92±0.27
L* value	63.66±1.17^{w}	62.46±2.08^{wx}	62.23±1.28^{wx}	60.82±0.76^{x}	59.14±1.29^{y}
a* value	2.82±0.78	2.35±0.14	2.51±0.11	2.50±0.04	2.62±0.05
b* value	11.54±0.07	11.62±0.46	11.64±0.31	11.71±0.48	11.79±0.40

$^{w, x, y, z}$ Means within a row that have different superscripts are significantly different ($p < 0.05$).

Table 2: Changes in water holding capacity and cooking loss of Chinese meatballs with various amounts of mechanically deboned bullfrog meat (MDBM) added during refrigerated storage.

MDBM added (%)	Water holding capacity	Cooking loss
0	37.30±4.99^{a}	4.27±0.71^{a}
7.5	30.21±2.60^{b}	4.33±0.96^{a}
15.0	27.71±5.69^{bc}	4.70±1.20^{a}
22.5	24.29±3.99^{cd}	6.14±2.35^{ab}
30.0	21.91±3.65^{d}	7.11±2.11^{b}

$^{a, b, c, d}$ Means within a column that have different superscripts are significantly different ($p < 0.05$).

Table 3: Changes in pH and TBA values of Chinese meatball with various amounts of mechanically deboned bullfrog meat (MDBM) added during refrigerated storage.

MDBM	Storage time (day)			Storage time (day)		
added (%)	0	7	14	0	7	14
		pH values		TBA (mg malonaldehyde/kg sample)		
0	6.37±0.06^{az}	6.11±0.04^{ay}	5.81±0.05^{ax}	1.59±0.64^{dx}	1.70±0.14^{dx}	1.89±0.18^{dx}
7.5	6.43±0.02^{bz}	6.17±0.00^{by}	5.87±0.02^{bx}	3.85±0.65^{cy}	3.93±0.14^{cy}	4.17±0.11^{cxy}
15.0	6.47±0.0^{bcz}	6.22±0.01^{cy}	5.99±0.01^{cx}	4.09±0.73^{cy}	4.19±0.12^{cy}	4.38±0.06^{cxy}
22.5	6.51±0.01^{cdz}	6.29±0.02^{dy}	6.02±0.01^{cx}	5.20±0.87^{bx}	5.40±0.37^{bx}	5.60±0.46^{bx}
30.0	6.54±0.01^{dz}	6.37±0.02^{ey}	6.08±0.01^{dx}	6.50±1.22^{ay}	6.58±0.80^{ay}	6.77±1.01^{axy}

$^{a, b, c, d}$ Means within a column in the same test that have different superscripts are significantly different ($p < 0.05$).
$^{x, y, z}$ Means within a row in the same test that have different superscripts are significantly different ($p < 0.05$).

Conclusions

In conclusion, Chinese meatballs that had 7.5% of mechanically deboned *Rana catesbeiana* meat added during manufacturing was acceptable based on the physic-chemical qualities.

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