51st International Congress of Meat Science and Technology
August 7-12, 2005 – Baltimore, Maryland USA

INDONESIAN BAKSO MEATBALL COMPOSITION, TEXTURE, AND STRUCTURE WITH FROZEN MEAT AND PRODUCT SOTRAGE TIMES

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Key Words: bakso, frozen, texture, SEM structure, composition, processing

Introduction

Meatballs and fishballs are popular convenient meat products in Asia. Meatballs in Indonesia, known as bakso, are made from prerigor meat or with meat before completion of rigor mortis that has been emulsified and mixed with salt, tapioca starch, and garlic (Purnomo, 1990). The batter mixture is formed into balls and cooked before serving with boiled chicken stock or soup, commonly distributed from pushcarts at street corners (Pandisurya, 1983). Consumers prefer tougher, but more elastic, bakso (Yuliati, 1999). Commercial production of bakso has been difficult for Indonesian meat procesors because sufficient quantities of prerigor or early postmortem meat materials are not readily available. Bakso from postrigor beef gave only slightly different textural properties than bakso using early postmortem meat with higher elasticity with 15% than 5 or 10% tapioca starch (Rahardiyan and McMillin, 2004). Use of frozen postmortem beef would provide more flexibility in raw material procurement and processing schedules.

Objectives

The objective of the study was to compare the texture, structure, and composition of bakso meatballs made from postrigor beef after different raw material frozen storage times and after different frozen storage times of the cooked bakso meatballs.

Methodology

Semimembranosus and *Semitendinosus* muscles were deboned within 3¾ hours postmortem from carcasses of commercially slaughtered (RPH Pegirian Slaughter House, Surabaya, East Java, Indonesia) local Ongole crossbred grass-fed cattle 2 to 4 years old. The beef was stored at 10°C during 1 hour transport to the meat plant (PT. Eloda Mitra, Sidoarjo, East Java, Indonesia) in a refrigerated truck. The meat was divided randomly into four equal portions for immediate usage (early postmortem), chilled overnight and used the following day (0 month postrigor), or stored frozen for usage after 2 or 4 months of storage (2 month postrigor and 4 month postrigor). The pH of early postmortem meat was 5.42-5.74 while the late postmortem meat had pH of 5.08-5.62.

Meat was weighed (20.51 kg, 81.4% of batch) and chopped (bowl chopper, K.G. Wetter, Germany) for 20 minutes with salt (1.6%), sodium tripolyphosphate (0.6% STPP, $Na_5P_3O_{10}$, Albert & Wilson Phosphate Groups, Indonesia), cane sugar (0.6%), monosodium glutamate (0.8% MSG, PT. Ajinomoto, Indonesia), and tapioca starch (15% National® 7, National Starch and Chemical, Singapore). Crushed ice was added (5%) to maintain batter temperature at 15°C. Balls of ~14g were formed (meatball former, Chuang Zong Baller, Taiwan) and then boiled at 100°C for 20 minutes in an open boiler (PT. Mastrada, Indonesia), drained on perforated aluminum trays until the surface was dry, and packed in polyethylene bags (limited low density 0.15 mm thickness, Top Printing Indonesia Co., Indonesia) at 40 balls/bag for vacuum packaging (Henkelman H-800 Double Chamber, Netherlands). Three packs each of early postmortem bakso and post rigor bakso were sampled for analysis time of 0 month. The remaining packs were frozen at -20°C and 3 packs each of early postmortem and post rigor bakso were thawed and tested after 2 and 4 months of frozen storage. After 2 and 4 months of frozen meat storage, 61.54 kg of meat were thawed and processed into cooked bakso balls using the previous procedures. Three packages of cooked bakso were tested initially and remaining bakso packs were stored at -20°C for an additional 2 or 4 months before testing.

Composition of bakso was determined as moisture (method 950.46) and fat (method 960.39, AOAC, 1990). Lipid oxidation was evaluated as TBARS values with the method of Wu et al. (2000). Texture analyses (Lloyd Universal Testing Model-1000s, England) according to Hidayati (2002) and Yuliati (1999) using 4 mm upper cycle limit, 3 mm lower cycle limit, compression mode, and 60 mm/min test speed on 10-mm sample cubes were reported as minutes/gram for elasticity and in newtons for gel strength (hardness) and shear force values. Samples for scanning electron microscope procedure were prepared according to Hidayati (2002) and Yuliati (1999) by slicing bakso 2 to 3-mm thick with a razor blade. Samples were fixed with 2% glutaraldehyde in a pH 7.3 phosphate buffer and critical point dried (Sumdri-780 Sample Drying, USA) for 72 hours. Each sample was coated with 24 carat gold with an ion sputter fine coater (JEOL-GLE4X, JEOL Technic Co. Ltd., Japan) for 1.5 minutes or 0.25-mm thickness for observation at 1500 times magnification (JEOL GSM-T100 Scanning Electron Microscope, JEOL Technic Co. Ltd., Japan).

Main effects of meat storage and bakso storage times, interactions, and replications were analyzed in two separate designs using analyses of variance and least squares mean separations at probability value of 0.05 (general linear model procedures for complete randomized design, 1998, SAS Inst., Inc., Cary, NC). The first design compared properties of bakso after post rigor meat frozen storage times of 0, 2, and 4 months and bakso frozen storage times of 0, 2, and 4 months. The second design compared bakso from early postmortem and post rigor meat after 0, 2, and 4 months of frozen bakso storage. Each batch of bakso was an experimental unit in the 6 experimental replications.

Results & Discussion

Replication in this study had no effects ($P>0.05$) on any bakso properties. Of the composition, stability, and textural properties, only lipid stability, as indicated by TBARS, increased ($P<0.05$) with increased frozen storage time of the frozen bakso meatballs (Table 1). The phospholipids in frozen meat are susceptible to fat oxidation

(McMillin, 1996). Bakso made of 0 month frozen stored post rigor meat appeared to have a more web-like protein strand network than in bakso made from meat stored frozen for 2 months (not shown) and 4 months (Figure 1).

Bakso composition was not different ($P>0.05$) with meat rigor condition or frozen storage times (Table 2). TBARS values of bakso from post rigor meat at 0 months of bakso frozen storage were higher ($P<0.05$) than bakso from early postmortem meat. Bakso from post rigor meat increased in TBARS value during the first 2 months of frozen storage, while bakso from early postmortem beef had a constant decrease ($P<0.05$) in lipid stability throughout the frozen storage period. Bakso from postrigor meat was less elastic and had less gel strength than bakso from early postmortem meat. Texture did not change with frozen storage time of bakso.

Conclusions

The substitution of post rigor meat for early postmortem meat in bakso production using 0.6% STPP, 1.6% NaCl, and 15% starch tapioca resulted in bakso with minimal composition and texture differences. The decrease in oxidative stability of bakso made from post rigor meat after 2 and 4 months of frozen storage compared with the use of early postmortem meat or bakso stored frozen for 0 months must be addressed by inclusion of commercial ingredients to minimize potential off-flavors of the precooked bakso products. Meat stored frozen for 2 and 4 months was still suitable as raw material for bakso production.

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Tables and Figures

Table 1. Proximate analysis, lipid stability, and texture of bakso from postmortem beef.

Meat storage (mo)	Bakso storage (mo)	Moisture (%)	Fat (%)	TBARS (mg/kg)	Elasticity (min/g)	Gel strength (N)	Shear force (N)
0	0	70.75	0.22	1.524^{c}	0.552	38.884	22.272
0	2	70.73	0.21	3.061^{a}	0.537	38.804	22.232
0	4	70.57	0.19	3.036^{a}	0.537	38.778	22.210
2	0	70.77	0.22	1.612^{bc}	0.545	38.742	22.233
2	2	70.73	0.20	2.811^{ab}	0.531	38.532	22.218
2	4	70.62	0.19	2.989^{a}	0.523	38.519	22.208
4	0	70.75	0.21	1.519^{c}	0.536	38.537	22.160
4	2	70.71	0.20	2.706^{ac}	0.522	38.507	22.118
4	4	70.52	0.20	3.069^{a}	0.517	38.496	22.150
	SEM	0.37^{nd}	0.01^{nd}	0.255	0.016^{nd}	0.202^{nd}	0.468^{nd}

Table 2. Properties of bakso from early postmortem and postrigor meat after 0, 2, and 4 months frozen storage.

Meat condition	Storage (mo)	Moisture (%)	Fat (%)	TBARS (mg/kg)	Elasticity (min/g)	Gel strength (N)	Shear force (N)
Postrigor	0	70.75	0.22	1.524^{bc}	0.552^{bcd}	38.884^{b}	22.272
Postrigor	2	70.73	0.21	3.061^{a}	0.537^{cde}	38.805^{b}	22.232
Postrigor	4	70.57	0.19	3.036^{a}	0.537^{c}	38.778^{b}	22.210
Early	0	70.76	0.21	0.922^{d}	0.651^{a}	40.632^{a}	23.175
Early	2	70.75	0.20	1.438^{bcd}	0.624^{ab}	40.507^{a}	23.158
Early	4	70.61	0.18	1.655^{b}	0.613^{abc}	40.506^{a}	23.153
	SEM	0.173^{nd}	0.01^{nd}	0.119	0.016	0.224	0.274^{nd}

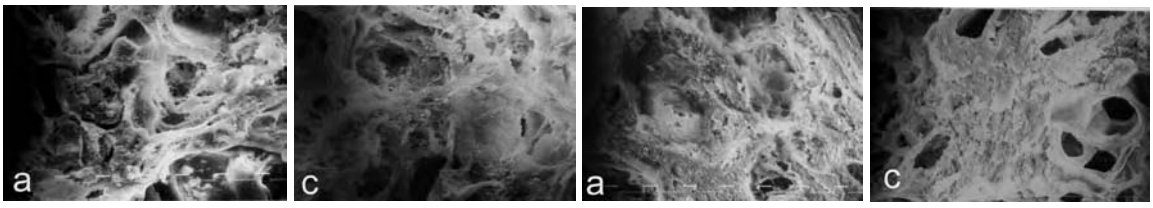

Figure 1. Scanning electron microscopy at 1500x magnification of bakso made of post rigor meat stored frozen 0 month (left micrographs) and 4 months (right micrographs) after 0 (a) and 4 (c) months of frozen bakso storage.