

The effect of trim conditions and massaging times on quality characteristics of Som-fug from tilapia trim meat

Pacharee Srisawad¹ and Somsamorn Gawborisut^{1*}

ABSTRACT: Production of Som-fug, a Thai traditional fermented fish sausage, from under-utilized tilapia trim meat, was explored. The objective of this study was to investigate conditions of tilapia trim meat (un-minced and minced) and massaging times (5 and 10 minutes) for Som-fug production. Uncooked Som-fug samples from 4 treatments including 1) un-minced trim meat and 5 minute massaging (UM-5), 2) un-minced trim meat and 10 minute massaging (UM-10), 3) minced trim meat and 5 minute massaging (M-5), and 4) minced trim meat and 10 minute massaging (M-10), were analyzed for total plate count (TPC), yeast and mold (YM), lactic acid bacteria (LAB), pH, and sensorial acceptability. Baked Som-fug samples were also evaluated for sensorial acceptability. The study showed that conditions of tilapia trim meat and massaging times did not affect the TPC, YM, LAB, pH, sensorial acceptability scores of uncooked samples (interior color, odor, and overall acceptability), and sensorial acceptability scores of baked samples (odor, mouth-feel texture, flavor, and overall acceptability). However, the conditions and the massaging times affected appearance and hand-feel texture scores of uncooked samples, as well as appearance and interior color scores of baked samples. For 5 minute massaging time, minced tilapia trim meat (M-5) yielded the better sensorial scores, compared to un-minced tilapia trim meat (UM-5). For 10 minute massaging time, the minced (M-10) and the un-minced (UM-10) yielded the same sensorial results. On average, 10 minute massaging produced better sensorial scores, compared to 5 minute massaging. If 10 minute massaging is employed, either un-minced or minced tilapia trim meat can be used for Som-fug production. Either UM-10 or M-10, therefore, benefited Som-fug production from tilapia trim meat. **Keywords:** tilapia, trim meat, un-minced, minced, massaging time

Introduction

Som-fug, a Thai traditional fermented fish sausage, is widely consumed in every part of Thailand (National Research Council of Thailand, 1982). The product is known in different local names such as Som-fug (the Northeastern Thailand), Pla-fug (the Northern Thailand), and Nham-Pla (the Central Thailand). Som-fug is

composed of minced or grounded fish meat, cooked rice, minced or chopped garlic, and salt (Paludan-Müller et al., 1999; Riebroy et al., 2004; Chuaphohak, 2006; Kongkiattikajorn, 2015). The ingredients are combined, and massaged or hand-kneaded at low temperature, until the mixture becomes a sticky paste. Sugar may be added in Som-fug mixture to enhance the taste (Thai Industrial Standards Institute, 2012).

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The mixture is then stuffed into a plastic casing or wrapped in banana leaves, and allowed to ferment at for 2-5 days at 30 °C (Riebroy et al., 2007). Som-fug can be grilled or deep fried, and served as a main dish with cooked rice, or as a snack with vegetable (Riebroy et al., 2004).

To produce Som-fug with good texture, Chuaphohak (2006) described that ground or minced fish meat should be massaged for 5-10 minutes. Salt is gradually added during massaging. Cooked rice and garlic are then blended, and briefly mixed with the meat. After that, sugar is added, and mixed for another 5 minutes. Finally, Som-fug mixture is stuffed into a plastic casing or wrapped in banana leaves, and allowed to ferment. The different production techniques and ingredients were used by Riebroy et al. (2007). The researchers mixed surimi (3 kg), garlic (0.15 kg), ground steamed rice (0.45 kg), and salt (90 g) for 15 minutes. The mixture was then stuffed into a polyethylene casing, sealed tightly, and incubated at 30°C up to 72 hr.

Natural freshwater species, used for Som-fug production, include great white sheatfish (*Wallagonia attu* Block), pangas catfish (*Pangasius pangasius* Hamilton), Whisker sheatfish (*Kryptopterus bleekeri* Günther), featherback (*Notopterus chitala* Hamiton, *N. blanci*, *N. borneensis*, and *N. chitala* Buchanan), silver carp (*Puntius* sp.), giant snake-head fish (*Ophicephalus micropeltes*), and barb (*Cyclocheilichthys* sp.) (National Research Council of Thailand, 1982). Rohu (*Labeo rohita*), considered low cost freshwater fish, and marine fish such as big-eye snapper (*Priacanthus tayenus*), can also be used (Riebroy et al., 2004; Riebroy et al., 2007). Tilapia trim meat, an under-utilized product from tilapia filleting process, may be used as an alternative low cost material for

Som-fug production. Commercially available tilapia trim meat can be purchased directly from tilapia fillet producers.

Tilapia trim meat is small pieces of meat, trimmed from the belly flabs and the rims of tilapia fillets (**Figure 1c**). The trimming process gives the fillets a desirable appearance, and reduces fat content, causing rancid off-flavor (Suthipan, 2011). Homehong (2014) reported that tilapia trim meat contains protein of 17.41%, fat of 22.12%, moisture of 58.98%, and ash of 0.65%. Tilapia meat and fillet are accounted for 1.45% and 31.48% of the whole fish weight, respectively (Prechawat, 2015). In 2014, Thailand exported 2,431 tons (31.48%) of chilled and frozen tilapia fillets (Nurit, 2015). It is, therefore, estimated that 111.97 tons (1.45%) of tilapia trim meat were produced in 2014. Commercial frozen tilapia trim meat was sold for 40-50 Bath/Kg in 2015 (Prechawat, 2015). This nutritious low-price tilapia trim meat can be further used for Som-fug production.

The use of tilapia trim meat for Som-fug production was reported by Gawborisut et al. (2014). The researchers relied on the traditional method for Som-fug production, in which massaging process was carried out by hand-kneading. Kneading times of 2, 4, 6, 8 and 10 minutes were investigated. The results of instrumental texture analysis, referred as shear force, showed that kneading times of 2-6 minutes did not improve of the texture of Som-fug. However, kneading times of 8-10 minutes tended to increase the texture of the product. Chuaphohak (2006) also recommended 5-10 minute massaging for preparing Som-fug from regular ground or minced fish meat. Riebroy et al. (2007) employed 15 minute massaging for preparing Som-fug from surimi.

Massaging process may play an important role in improving the texture of Som-fug, produced from tilapia trim meat. Zochowska-Kujawska et al. (2007) stated that massaging process breaks meat structures, causing an increase in brine absorption and protein extraction, consequently increasing meat tenderness and cohesiveness. The increase in massaging time may able to break more muscle structures in tilapia trim meat, transform pieces of tilapia trim meat into paste, increase brine absorption and protein extraction of the meat, and improve texture of Som-fug. If the transformation of tilapia trim meat into paste can be achieved, the mincing process, used for dividing the meat into fine pieces prior to massaging process, can be skipped. Without the mincing process, Som-fug production is simplified, and un-minced-tilapia trim meat can be directly used for the production. We, therefore, propose to investigate effects of conditions of tilapia trim meat (un-minced and minced) and massaging times (5 and 10 minutes) on quality parameters of Som-fug.

Materials and Methods

Som-fug Production

Four blocks (1 kg/block) of frozen tilapia trim meat from the same production lot were purchased from Grobest Frozen Co. Ltd. (Nakhon Phanom, Thailand), and kept in a freezer until they were used. Prior to using, the blocks were thawed overnight in a refrigerator ($4\pm 2^{\circ}\text{C}$), hand mixed, and divided into 4 portions. Each portion was packed in a polypropylene (PP) plastic bag, iced, and used within 3 hr. Two conditions of tilapia trim meat (un-minced and minced) (Figure 2a and 2b) and two massaging times (5 and 10 minutes) were brought to be in the experiment.

Totally, four treatment combinations, randomly assigned to four bags of iced tilapia trim meat, were 1) un-minced trim meat and 5 minute massaging (UM-5), 2) un-minced trim meat and 10 minute massaging (UM-10), 3) minced trim meat and 5 minute massaging (M-5), and 4) minced trim meat and 10 minute massaging (M-10). The minced trim meat was prepared by mincing ice-cold tilapia trim meat for 3 minutes in a food processor (MCM640660, Bosch, Bratislava, Slovakia).

Som-fug was composed of un-minced or minced tilapia trim meat, cooked non-glutinous white rice, garlic, salt, and sugar at the ratio by weight of 5:1:1:0.15:0.15, consistent with Chuaphohak (2006). The method for Som-fug preparation, as described by Chuaphohak (2006), was used in the experiment. Iced un-minced or minced tilapia trim meat was mechanically massaged for 5 or 10 minutes in a mixing bowl using a stand mixer equipped with a paddle attachment (Kitchen Aid, Benton Harbor, MI, USA). Salt was gradually added in the meat during massaging. Ice-cold gel packs were used to wrap around the mixing bowl to control temperature of fish paste to $< 20^{\circ}\text{C}$, which is the chopping temperature exhibiting the highest gel strength in surimi paste produced warm freshwater fish, as referred by Poowakanjana et al. (2012).

Mixture of rice and garlic was prepared by blending cooked non-glutinous white rice and garlic in a food processor. This mixture was then combined and briefly mixed with the fish paste. After that, sugar was added, and mixed for another 5 minutes until sugar granules were completely dissolved. Finally, Som-fug mixture (Figure 2c and 2d) was stuffed into a plastic casings of size 35 mm x 180 mm (diameter x length).

Cotton ropes were used to tie the casing ends. Som-fug samples (Figure 2e) were fermented in an incubator at $28\pm 1^{\circ}\text{C}$ for 48 hr, and analyzed for microbial contents and pH. After that, uncooked

and baked Som-fug samples were evaluated for sensorial acceptability. The experiments were carried out in triplicate using tilapia trim meat from three different production lots.

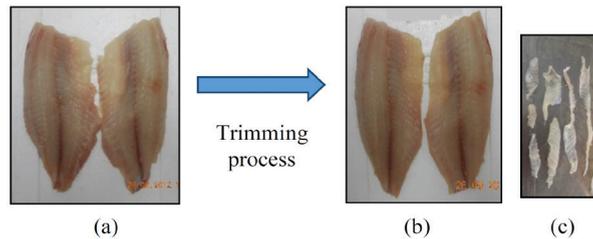


Figure 1 Tilapia fillets before being trimmed (a), after being trimmed (b), and commercial tilapia trim meat with the sizes of 0.2-1.0 x 2-10 cm (width x length) (c)

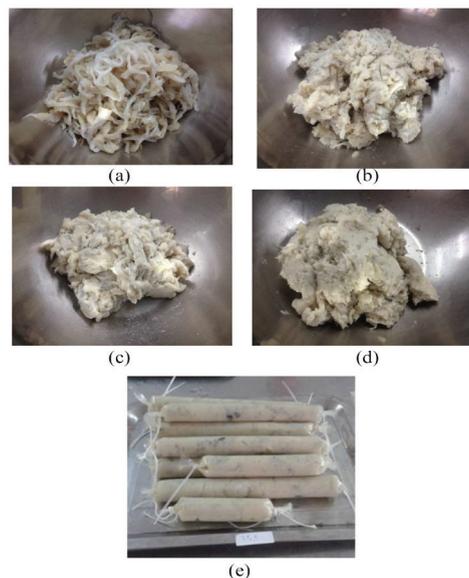


Figure 2 Un-minced tilapia trim meat (a), minced tilapia trim meat (b), un-minced tilapia trim meat after being mixed with Som-fug ingredients (c), minced tilapia trim meat after being mixed with Som-fug ingredients (d) and Som-fug produced from tilapia trim meat in plastic casings (e)

Analyses

Som-fug samples, fermented at $28\pm 1^{\circ}\text{C}$ for 48 hr, were determined for total plate count (TPC), yeast and mold (YM), lactic acid bacteria (LAB), pH, and sensorial acceptability. The TPC was enumerated in standard plate count agar (BBL, Sparks, MD, USA) at $30\pm 0.1^{\circ}\text{C}$ for 48 hr (Morton, 2001). The YM was determined by using acidified

yeast malt agar (BBL, Sparks, MD, USA), and incubated at $25\pm 0.1^{\circ}\text{C}$ for four days (Visessanguan et al., 2006). The LAB was enumerated in de Man, Rogosa, and Sharpe (MRS) agar (BBL, Sparks, MD, USA) at $37\pm 0.1^{\circ}\text{C}$ for 48 hr (Daengprok et al., 2002). All microbial counts were expressed as a log CFU/g sample.

The pH was determined as described by Chiou and Huang (2004). Five grams of Som-fug were homogenized with 50 ml of freshly boiled deionized-water, and measured by Satorius PP-150 pH meter (Sartorius Corp., Edgewood, NY, USA).

Scores of sensorial acceptability were given by 45 panelists acquainted with Som-fug. Uncooked and baked Som-fug samples were evaluated separately by using a nine-point hedonic scale (1 = extremely dislike, 5 = neither like nor dislike, 9 = extremely like) in accordance to Meilgaard et al. (1991). Prior to evaluating, samples were randomly selected and coded with a three digit random numbers. Appearance, interior color, odor, hand-feel texture, and overall acceptability of uncooked samples were scored. Baked samples were prepared by baking Som-fug at $180\pm 5^{\circ}\text{C}$ in a hot-air oven until the internal temperature of the samples reached 70°C , as described by AOAC (1990). After being cooled to room temperature, the samples were scored for appearance, interior color, odor, flavor, mouth-feel texture, and overall acceptability.

Statistical analysis

Two conditions of tilapia trim meat (un-minced and minced) and two massaging times (5 and 10 minutes) were investigated. The experiment was conducted by using the 2x2 factorial arrangement in a randomized complete block design (RCBD). Data were analyzed by using SAS-University Edition (SAS Institute Inc., Cary, NC) with a 95% confidence level. Means were separated by using the least significant difference (LSD) test.

Results and Discussion

Microbial contents (TPC, YM, and LAB) of Som-fug after being fermented for 48 hr, were not

significantly different ($P>0.05$) among treatments (UM-5, UM-10, M-5, and M-10) (Figure 3). The results indicated that conditions of tilapia trim meat (un-minced and minced) and massaging times (5 and 10 minutes) did not affect the microbial contents. Knipe (2014) stated that massaging process, involving friction energy that is generated from pieces being rubbed and massaged against each other by rotating paddles, can increase temperature of meat. In cooked ham, an increasing temperature during massaging poses a risk for bacterial growth, so using cooling circuit to control the temperature is recommended (Arboix, 2014).

The increase in temperature may occur during massaging tilapia trim meat with salt. It, however, was controlled by wrapping cold gel packs around the mixing bowl. The well-controlled low temperature may prevent microbial growth during massaging, thus yielding indifferent microbial loads among Som-fug samples. These indifferent microbial loads consequently generated the non-significant differences in TPC, LAB, and YM counts after 48 hr fermentation, as shown in Figure 3. Our unpublished preliminary study on temperature control, during massaging tilapia trim meat with salt, showed that massaging time of 15 minutes tended to increase temperature of Som-fug to $> 20^{\circ}\text{C}$. The increase in temperature may compromise gel strength of the product, and may increase microbial growth. Massaging tilapia trim meat with salt, therefore, should be limited to < 15 minutes. In this experiment, massaging time was maintained from 5-10 minutes to avoid the consequences of gel strength reduction and microbial proliferation. Our recent results proved that massaging times of 5-10 minutes produced no effect on microbial counts in Som-fug after 48 hr fermentation.

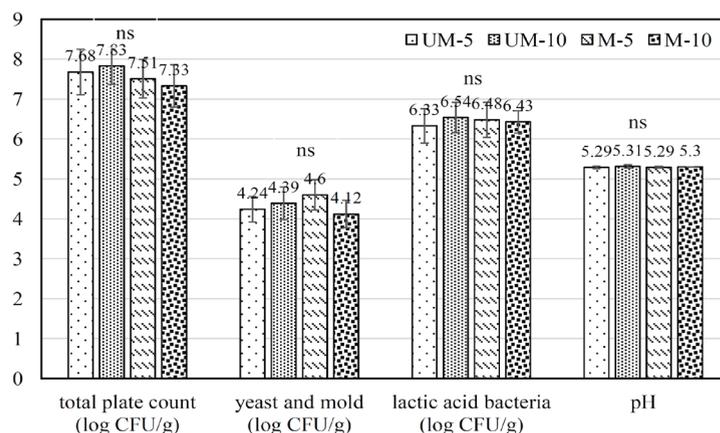


Figure 3 Effect of conditions of tilapia trim meat and massaging times on total plate count, yeast and mold, lactic acid bacteria, and pH of Som-fug after 48 hr fermentation. UM-5: un-minced trim meat and 5 minute massaging, UM-10: un-minced trim meat and 10 minute massaging, M-5: minced trim meat and 5 minute massaging, M-10: minced trim meat and 10 minute massaging. The “ns” designates that graphs, within each analytical parameter, are not significantly different ($P>0.05$) according to LSD.

pH levels of Som-fug samples were not significantly different ($P>0.05$) among treatments (UM-5, UM-10, M-5, and M-10) (Figure 3). The conditions of tilapia trim meat and massaging times played no role on pH reduction during the fermentation process. The reduction of pH in Thai traditional fermented meat is caused lactic acid bacteria fermentation (Visessanguan et al., 2006). During the fermentation, lactic acid bacteria, such as *Lactobacilli* and *Pediococci*, change the starch in rice into organic acids, mainly lactic acid (Visessanguan et al., 2006). The acids then decrease the pH of the products. It was obvious that the experimental LAB counts (6.33-6.54 log CFU/g) were not significantly different among the treatments (Figure 3). The LAB from each treatment may produce indifferent amount of organic acids, thus contributing to the non-significant difference in pH levels, as shown in Figure 3.

Sensorial acceptability scores of uncooked Som-fug are illustrated in Figure 4. There was no

significant difference among treatments (UM-5, M-5, UM-10, and M-10) with regard to interior color, odor, and overall acceptability scores (Figure 4). For uncooked Som-fug with 5 minute massaging, minced tilapia trim meat (M-5) received a significantly higher ($P<0.05$) score in appearance, than un-minced tilapia trim meat (UM-5). However, for 10 minute massaging, the difference in appearance between the minced (M-10) and the un-minced (UM-10) was not evident ($P>0.05$) (Figure 4). The UM-10 and M-10 received significantly higher ($P<0.05$) in appearance scores than UM-5 and M-5 (Figure 4). On average, 10 minute massaging received better scores in appearance, compared to 5 minute massaging.

Panelist records showed that, regardless of condition of tilapia trim meat (un-minced or minced), Som-fug with 10 minute massaging produced well-blended and uniform appearance. Zochowska-Kujawska et al. (2007) stated that massaging process can break muscle structures

of meat. Massaging time of 10 minutes may be sufficient for breaking muscle structures of un-minced tilapia trim meat into paste, thus producing as similar well-blended appearance as minced tilapia trim meat did. On contrary, massaging time of 5 minutes was insufficient for breaking the muscle structures into paste, causing un-blended mixture. The un-blended mixture of UM-5 and M-5 then exhibited lower appearance scores, compared to UM-10 and M-10.

The results also showed that appearance scores of UM-10 and M-10 were not statistically different ($P>0.05$). To conclude that, if sufficient

massaging time of 10 minutes is employed, un-minced tilapia trim meat can be used for Som-fug production. Upon using the un-minced meat, mincing process can be skipped. The skipped process may reduce the investment for mincing equipment (a food processor) and may simply the process. Concerning the reduction of investment, the simplified process, and the better appearance scores of uncooked samples, the use of un-minced tilapia trim meat in combination with 10 minute massaging (UM-10) should be used for Som-fug production.

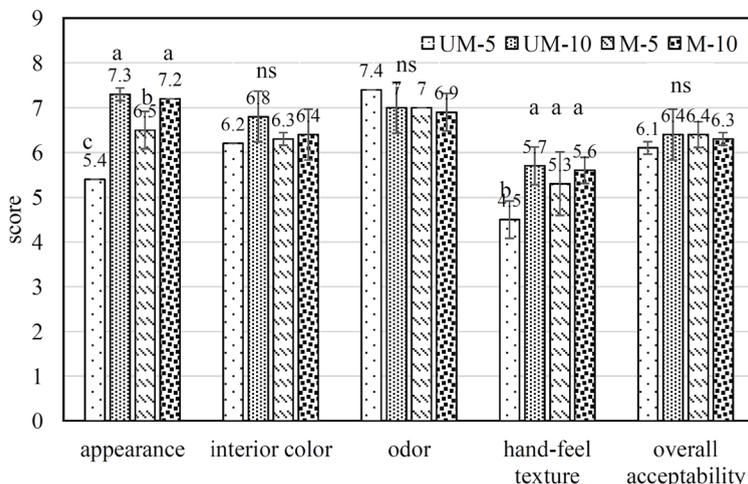


Figure 4 Effect of conditions of tilapia trim meat and massaging times on sensorial acceptability scores of uncooked Som-fug. UM-5: un-minced trim meat and 5 minute massaging, UM-10: un-minced trim meat and 10 minute massaging, M-5: minced trim meat and 5 minute massaging, M-10: minced trim meat and 10 minute massaging. Graphs, within each sensorial attribute, with different letters are significantly different ($P<0.05$) according to LSD. The “ns” designates that graphs, within each sensorial attribute, are not significantly different ($P<0.05$) according to LSD.

Hand-feel texture scores of uncooked Som-fug are illustrated in **Figure 4**. The UM-5 produced a significantly lower hand-feel texture score, compared to UM-10, M-5, and M-10 ($P<0.05$, **Figure 4**). The results showed that texture scores of UM-10, M-5, and M-10, ranged from 5.3-5.7, were not significantly different ($P>0.05$). For 5 minute massaging, un-minced tilapia trim meat (UM-5) produced a significantly lower ($P<0.05$)

hand-feel texture score, compared to minced tilapia trim meat (M-5). Therefore, the conditions of tilapia trim meat (minced and un-minced) affected only the samples, exposed to insufficient massaging time of 5 minutes. For sufficient massaging time of 10 minutes, the trim meat conditions yielded statistically indifferent hand-feel texture scores. Therefore, either UM-10 or M-10 benefited the production of Som-fug from tilapia trim meat.

On average, 10 minute massaging offered better hand-feel texture scores, compared to 5 minute massaging. Zochowska-Kujawska et al. (2007) reported that massaging process breaks meat structures, causing an increase in brine absorption and protein extraction, consequently increasing in meat tenderness and cohesiveness. Massaging of 10 minutes may cause more muscle breakdown, inducing more salt absorption and protein extraction. The increasing salt absorption and protein extraction may improve tenderness and cohesiveness of the experimental Som-fug, consequently benefiting the hand-feel texture scores of the product.

Sensorial acceptability scores of baked Som-fug are illustrated in Figure 5. There was no significant difference among treatments (UM-5, M-5, UM-10, and M-10) with regard to odor,

mouth-feel texture, flavor, and overall acceptability scores (Figure 5). However, appearance and interior color scores were significantly different ($P < 0.05$) among the treatments (Figure 5). The appearance score of UM-5 was significantly lower ($P < 0.05$) than those of M-5, UM-10, and M-10. Panelists' records showed that UM-5 was not well-blended, causing un-uniform appearance and reducing the appearance score. Appearance scores of UM-10, M-5, and M-10, ranged from 6.6-7.0, were not significantly different ($P > 0.05$). On average, 10 minute massaging yielded significantly higher ($P < 0.05$) appearance scores, compared to 5 minute massaging. The results indicated that, if sufficient massaging time of 10 minutes is employed, either un-minced or minced tilapia trim meat can be used for Som-fug production.

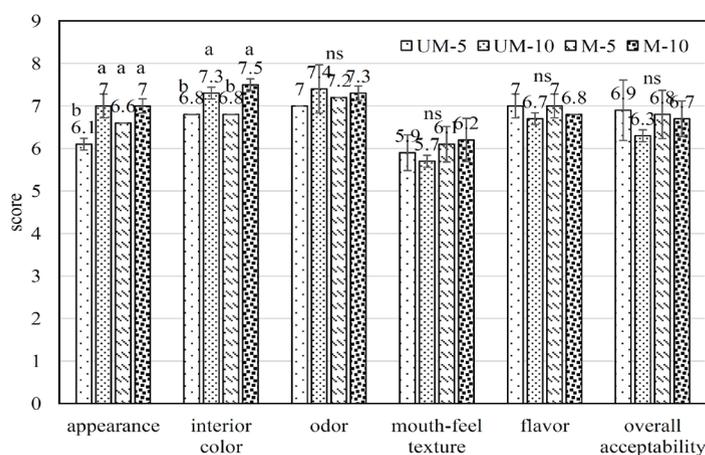


Figure 5 Effect of conditions of tilapia trim meat and massaging times on sensorial acceptability scores of baked Som-fug. UM-5: un-minced trim meat and 5 minute massaging, UM-10: un-minced trim meat and 10 minute massaging, M-5: minced trim meat and 5 minute massaging, M-10: minced trim meat and 10 minute massaging. Graphs, within each sensorial attribute, with different letters are significantly different ($P < 0.05$) according to LSD. The "ns" designates that graphs, within each sensorial attribute, are not significantly different ($P > 0.05$) according to LSD..

Interior color scores of baked Som-fug were significantly different ($P < 0.05$) among treatments (UM-5, M-5, UM-10, and M-10) (Figure 5). The 10 minute massaging (UM-10 and M-10) produced significantly higher ($P < 0.05$) interior

color scores, than 5 minute massaging (UM-5 and M-5). For 10 minute massaging, the un-minced (UM-10) and the minced (M-10) yielded non-significantly different ($P > 0.05$) interior color scores. The results indicated that, if sufficient

massaging time of 10 minutes is employed, either un-minced or minced tilapia trim meat can be used for Som-fug production. With regard to investment for mincing process, the use of un-minced tilapia trim meat, offering lower investment, should be used for Som-fug production.

Conclusions

The condition of tilapia trim meat and massaging time, recommended for Som-fug production, is the un-minced tilapia trim meat and 10 minute massaging (UM-10). The use of tilapia trim meat for Som-fug production reduces the cost of fish material by 40%, compared to the use of commercial tilapia fillet. It was noticeable that UM-10 yielded low hand-feel and mouth-feel texture scores (5.7 out of 9 points). The texture improvement, using food additive binders or using high quality tilapia fillets in combination with tilapia trim meat, should be further explored.

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