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Different Parameters in Development and Evaluation of Dry Fermented Sausages Processed From Blends of Broken Shrimp and Bronze Featherback *(Notopterus Notopterus)* Meat

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Abstract.

Utilization of small size broken shrimp meat from seafood factory creates new low-cost value added product that allow consumers access to nutritional protein products. Low-income consumers can benefit from products with reduced cost. The aim of this research was to develop and evaluate a new kind of dry fermented sausage by blending broken shrimp with *bronze featherback (Notopterus notopterus)* meat. Effect of blending ratio of broken shrimp to dried fermented sausage (15, 20, 25, 30%), fermentation time (1, 2, 3, 4 days) and drying time (2, 4, 6, 8 days) on the physico-chemical, microbiological, and sensory qualities of the dry fermented sausage were investigated. Results revealed that the optimal formula was recorded at blending ratio of broken shrimp to *Bronze featherback (Notopterus notopterus)* meat (25%), fermentation time (3 days) and drying time (6 days).

Keywords: *Broken shrimp, bronze featherback (Notopterus notopterus) meat, dry fermented sausage, physico-chemical, microbiological, sensory*

I. Introduction

Regarding to nutritive characteristic of raised white leg shrimp (*Litopenaeus vannamei*), it has good source of protein, carbohydrate, lipid, moisture and ash, calcium, sodium, potassium, manganese, copper, chromium (Gunalan, B. et al., 2013). Shrimps have low fat, less cholesterol and high polyunsaturated fatty accid (PUFA) content (Syama Daya, J. et al., 2013).

Bronze featherback *(Notopterus notopterus)* is one of the most conspicuous groups of fish in the Mekong. The peculiar knife-shaped body with a long anal fin, which is continuous with the caudal fin, readily identifies a featherback. The bronze featherback can be encountered just about everywhere in the Mekong basin, but it prefers standing or sluggish water. It migrates from the dry season refuges to spawn in rice fields. When the floodwaters recede, the fish migrates back to permanent streams and canals. Its favourite food consists of shrimps and aquatic insects. Although these fish, like other featherbacks, have more spines in their flesh than any other Mekong fish species, they are popular food fish. Most often the meat is used to make very tasty fish cakes. For nutritional value, bronze featherback meat is a good source of protein.

Sausage production involves three of the oldest forms of food preservation: salting, drying, and smoking (S. A. Palumbo and J. L. Smith, 1977). Sausage is a product in which meat flesh is mixed with additives, stuffed into suitable casings, and heat processed (Raju *et al.*, 2003). Fish sausage is a product that sausage manufactures have started producing due to changing consumer preferences toward healthier lifestyles, safer and cheaper foods (Panpipat and Yongsawatdigul, 2008; Nowsad and Hoque, 2009). Spotted featherback (*Chitala ornata*) is another species of bronze featherback. Piyawan Tachasirinukun (2016) examined the effect of setting conditions on proteolysis and gelling properties of spotted featherback (*Chitala ornata*) muscle. However, scientific results about the application of bronze featherback (*Notopterus notopterus*) in fish sausage are lacking.

There were few studies mentioned to the blending different materials to manufacture fermented sausage. A research assessed the quality of sausages prepared with 0, 20, 40, 60, 80 and 100% of MF from Nile tilapia filleting waste during storage at 0±0.3ºC (Paulo Roberto Campagnoli de Oliveira Filho et al., 2010). Another research aimed to obtain the best level of NaCl concentration with emphasis on the physico-chemical of Clarias fermented sausage (Happy Nursyam et al., 2013). A research was to develop and evaluate chickpea flour blended dry fermented sausages (Habtamu Asmare and Shimelis Admassu, 2013). A new fermented fish sausage product, based on monkfish, was developed by using an accelerated drying process (Katharina Stollewerk et al., 2014). Preparation of dried kofta formula from small size shrimp meat was noticed (Mahmoud FSAK et al., 2017). A study was conducted to determine the texture and quality parameters of surimi sausage which was prepared from saithe flesh, during the cold storage (Dinçer, M.T. et al., 2017). Different conditions impacting to physicochemical properties and sensory characteristics of bronze featherback sausage were investigated (Minh N. P., and Nga N. H., 2018). A study was to show how sausages produced with lantern fish (*Benthosema pterotum*) protein isolate at two levels 4% (sample A) and 2% (sample B), and then, the physicochemical and sensory properties of sausages (A and B) were determined during the storage (14, 30, and 60 days) at 4°C (Marzieh Moosavi-Nasab et al., 2018).

Shrimps and shrimp products are one of the most economically important products. To increase the variety of shrimp products, value added products should be considered. However, the use of small shrimps or broken shrimp meat for new products is still limited. The aim of this work was to study the feasibility of utilization of broken shrimp blended with bronze featherback *(Notopterus notopterus)* meat to create a new dry fermented sausage. This research focused on the effect of blending ratio of broken shrimp to dried fermented sausage (15, 20, 25, 30%), fermentation time (1, 2, 3, 4 days) and drying time (2, 4, 6, 8 days) on the proximate composition, physico-chemical, microbiological, and sensory qualities of the dry fermented sausage.

II. MATERIAL AND METHOD

2.1 Material

Broken shrimp (*Litopenaeus vannamei*) was collected from seafood processing factories in Mekong delta, Vietnam. Bronze featherback *(Notopterus notopterus)* meat was purchased from local market. They were selected in good quality and appearance and then be kept below 8^{o}C ready for experiments. Apart from that, we also used other ingredients such as NaCl, sugar, garlic, pepper, alcohol, honey, seasoning powder, edible coating.

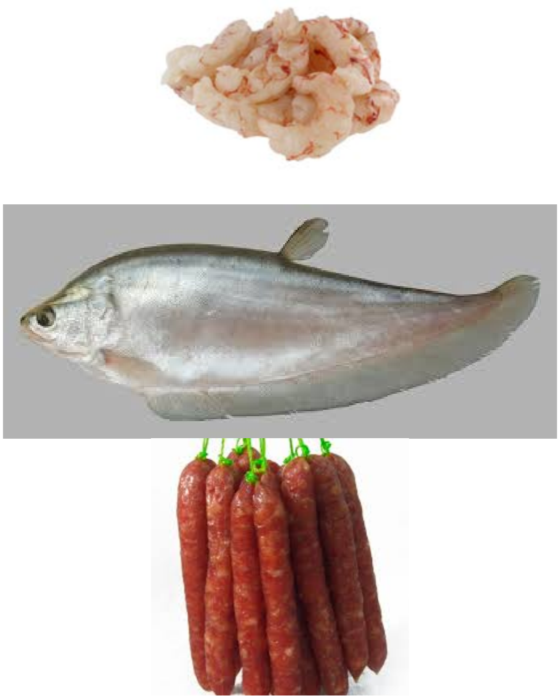

Figure 1. Broken shrimp, bronze featherback *(Notopterus notopterus)* meat, and dry fermented sausage

2.2 Researching method

2.2.1 Effect of blending ratio of broken shrimp and bronze featherback (Notopterus notopterus) meat to physico-chemical, microbiological and sensory characteristics of the dry fermented sausage

Different blending ratios of broken shrimp and bronze featherback *(Notopterus notopterus)* meat (15%, 20%, 25%, 30%) were examined. The optimal parameter was selected by measured different values such as physico-chemical (moisture content %, crude protein %, a_w, yield %, lactic acid %), microbiological (total plate count cfu/g), and sensory characteristics of the dry fermented sausage.

2.2.2 Effect of fermentation time to physico-chemical, microbiological and sensory characteristics of the dry fermented sausage

Different fermentation time (1 day, 2 days, 3 days, 4 days) was examined. The optimal parameter was selected by measured different values such as physico-chemical (moisture content %, crude protein %, a_w, yield %, lactic acid %), microbiological (total plate count cfu/g), and sensory characteristics of the dry fermented sausage.

2.2.3 Effect of drying time to physico-chemical, microbiological and sensory characteristics of the dry fermented sausage

Different drying time (2, 4, 6, 8 days) was examined. The optimal parameter was selected by measured different values such as physico-chemical (moisture content %, crude protein %, a_w, yield %, lactic acid %), microbiological (total plate count cfu/g), and sensory characteristics of the dry fermented sausage.

2.3 Physico-chemical, microbial and sensory evaluation

Moisture content (%) was determined by comparing the weights of the sample with the electronic balance. Crude protein (%) was measured by by AOAC (2000). Water actitity (a_w) was measured was measured by a water activity meter with the standard solution of 0.25 and 0.50 as the control samples.

Yield (%): The sausage batter samples weight (W_0) before processing was recorded after all the ingredients were mixed. After processing, the final dry fermented sausage sample weights (W_1) were recorded and the sausage yield was calculated according to the method described by Sukru and Omer (2011). Lactic acid (%) was determined in accordance with the AOAC (2000). The total plate count (cfu/g) was enumerated during the storage period by Petrifilm - 3M. The sensory attributes such as visual appearance, color, taste, flavor and acceptability was carried out by selected panel of judges (9 members) rated on a nine point hedonic scale.

2.4 Statistical analysis

The experiments were run in triplicate with three different lots of samples. Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Duncan's multiple range test (DMRT). Statistical analysis was performed by the Statgraphics Centurion XVI.

III. RESULT & DISCUSSION

3.1 Effect of blending ratio of broken shrimp and bronze featherback *(Notopterus notopterus)* meat to physico-chemical, microbiological and sensory characteristics of the dry fermented sausage

Different blending ratios of broken shrimp and bronze featherback *(Notopterus notopterus)* meat (15%, 20%, 25%, 30%) were examined. The optimal parameter was selected by measured different values such as physico-chemical (moisture content %, crude protein %, a_w, yield %, lactic acid %), microbiological (total plate count cfu/g), and sensory characteristics of the dry fermented sausage. From table 1, the optimal blending ratio of broken shrimp and bronze featherback *(Notopterus notopterus)* meat should be 25% so we choose this value for further experiments.

A study was to utilize small size shrimp meat for new products characterize with high nutritional value and easy preparation, beside to added value for small size shrimp. Small size shrimp meat was and used three formulas, formula1 (F1= dried shrimp meat 45% dried potato 35%), formula2 (F2= dried shrimp meat 50% and dried potato 30%) and formula3 (F3= dried shrimp meat 55% and dried potato 25%) (Mahmoud FSAK et al., 2017).

3.2 Effect of fermentation time to physico-chemical, microbiological and sensory characteristics of the dry fermented sausage

Different fermentation time (1 day, 2 days, 3 days, 4 days) was examined. The optimal parameter was selected by measured different values such as physico-chemical (moisture content %, crude protein %, a_w, yield %, lactic acid %), microbiological (total plate count cfu/g), and sensory characteristics of the dry fermented sausage. From table 2, the optimal fermentation time was noticed at 3 days so this value was selected for further experiments.

Different conditions impacting to physicochemical properties and sensory characteristics of bronze featherback sausage were investigated. Their results showed that 0.6% CMC, 0.2% alginate greatly reinforced the shear stress of surimi gels made from bronze feather muscle. Alginate and CMC were useful additives for improving the physicochemical properties and sensory characteristics of fish sausage. By grinding the paste in 2 minutes, sausage had a high holding water capacity. Fish sausage had the high score of consumer evaluation under sterilization in 115°C in 5 minutes (Minh N. P., and Nga N. H., 2018).

Table 1. Effect of blending ratio of broken shrimp and bronze featherback *(Notopterus notopterus)* meat (15%, 20%, 25%, 30%) to physico-chemical, microbiological and sensory characteristics of the dry fermented sausage

Blending ratio (broken shrimp: bronze featherback *(Notopterus notopterus)* meat, %)	**15**	**20**	**25**	**30**
Moisture (%)	22.12 ± 0.02^{a}	22.06 ± 0.02^{ab}	22.01 ± 0.02^{ab}	21.95 ± 0.02^{b}
Crude protein (%)	30.14 ± 0.02^{b}	30.23 ± 0.00^{ab}	30.29 ± 0.03^{ab}	30.34 ± 0.01^{a}
Water activity (a_w)	0.34 ± 0.01^{a}	0.35 ± 0.03^{a}	0.36 ± 0.01^{a}	0.37 ± 0.01^{a}
Yield (%)	48.73 ± 0.01^{c}	49.65 ± 0.01^{bc}	51.44 ± 0.00^{a}	50.15 ± 0.03^{b}
Lactic acid (%)	1.17 ± 0.01^{a}	1.16 ± 0.01^{ab}	1.14 ± 0.01^{ab}	1.12 ± 0.00^{b}
Total plate count (cfu/g)	$1.2x10^{1}\pm0.00^{a}$	$1.2x10^{1}\pm0.0^{a}$	$1.2x10^{1}\pm0.00^{a}$	$1.2x10^{1}\pm0.00^{a}$
Sensory score	7.01 ± 0.01^{b}	7.17 ± 0.01^{ab}	7.45 ± 0.01^{a}	7.31 ± 0.03^{ab}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 2. Effect of fermentation time to physico-chemical, microbiological and sensory characteristics of the dry fermented sausage

Fermentation time (day)	**1**	**2**	**3**	**4**
Moisture (%)	22.01 ± 0.02^{a}	21.86 ± 0.01^{ab}	21.70 ± 0.03^{ab}	21.65 ± 0.01^{b}
Crude protein (%)	30.29 ± 0.03^{a}	30.27 ± 0.02^{ab}	30.25 ± 0.01^{ab}	30.21 ± 0.01^{b}
Water activity (a_w)	0.36 ± 0.01^{a}	0.35 ± 0.00^{ab}	0.33 ± 0.02^{ab}	0.32 ± 0.02^{b}
Yield (%)	51.44 ± 0.00^{a}	51.40 ± 0.03^{ab}	51.37 ± 0.01^{ab}	51.32 ± 0.01^{b}
Lactic acid (%)	1.14 ± 0.01^{ab}	1.18 ± 0.00^{b}	1.23 ± 0.00^{ab}	1.29 ± 0.02^{ab}
Total plate count (cfu/g)	$1.2x10^{1}\pm0.00^{a}$	$1.1x10^{1}\pm0.01^{a}$	$0.9x10^{1}\pm0.01^{a}$	$0.8x10^{1}\pm0.03^{a}$
Sensory score	7.45 ± 0.01^{c}	7.78 ± 0.02^{b}	7.92 ± 0.02^{a}	7.83 ± 0.03^{ab}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 3. Effect of drying time (2, 4, 6, 8 days) to physico-chemical, microbiological and sensory characteristics of the dry fermented sausage

Drying time (day)	**2**	**4**	**6**	**8**
Moisture (%)	21.70 ± 0.03^{a}	19.35 ± 0.00^{b}	17.78 ± 0.02^{c}	16.93 ± 0.01^{d}
Crude protein (%)	30.25 ± 0.01^{b}	30.44 ± 0.02^{ab}	30.78 ± 0.03^{ab}	31.12 ± 0.02^{a}
Water activity (a_w)	0.33 ± 0.02^{a}	0.31 ± 0.01^{ab}	0.29 ± 0.01^{ab}	0.26 ± 0.03^{b}
Yield (%)	51.37 ± 0.01^{ab}	50.46 ± 0.03^{ab}	49.13 ± 0.02^{ab}	48.77 ± 0.00^{ab}
Lactic acid (%)	1.23 ± 0.00^{b}	1.27 ± 0.01^{ab}	1.31 ± 0.01^{ab}	1.35 ± 0.01^{a}
Total plate count (cfu/g)	$0.9x10^{1}\pm0.01^{a}$	$0.6x10^{1}\pm0.02^{a}$	$0.4x10^{1}\pm0.01^{a}$	$0.1x10^{1}\pm0.00^{a}$
Sensory score	7.92 ± 0.02^{d}	8.23 ± 0.01^{c}	8.74 ± 0.01^{a}	8.40 ± 0.03^{b}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

3.3 Effect of drying time to physico-chemical, microbiological and sensory characteristics of the dry fermented sausage

Different drying time (2, 4, 6, 8 days) was examined. The optimal parameter was selected by measured different values such as physico-chemical (moisture content %, crude protein %, a_w, yield %, lactic acid %), microbiological (total plate count cfu/g), and sensory characteristics of the dry fermented sausage. From table 3, the drying time should be 6 days so this value was selected for application.

The dry fermented sausages processed by blending of meat and other major ingredients with 20% chickpea flour, fermented for 48 h and dried for 12 days gave auspicious results in nutritional, microbial, and sensory qualities (Habtamu Asmare and Shimelis Admassu, 2013). A new fermented fish sausage product, based on monkfish, was developed by using an accelerated drying process. The product was manufactured, fermented, dried, and half of the samples were pressurized (600 MPa, 5 min, 13 C). Pathogens, technological microbiota, spoilage indicator bacteria from fish (hydrogen sulphite producing bacteria, coliforms and Escherichia coli) and physicochemical parameters were monitored during manufacturing and after 6, 13, 20 and 27 days of refrigerated storage at 4 and 8 C. Results showed that in the finished product, pathogens and spoilage indicator bacteria could not grow but decreased and *E. coli* was not detected during storage. Pressurization had an important reducing effect on technological microbiota, and eliminated L. monocytogenes, S. enterica, hydrogen sulphite producing bacteria and coliforms immediately after production and during refrigerated storage (Katharina Stollewerk et al., 2014).

There are many specific flavors due to the high number of available aromatic plants such as pepper, paprika, mustard, nutmeg, cloves, oregano, rosemary, thyme, garlic, onion, and so on. These compounds have a high impact on the aroma of fermented products (Ordóñez JA et al., 1999). The bacteria which play a significant role and commonly found in fermented sausages are lactic acid bacteria (Coppola R et al., 1998). These microorganisms are used as starter cultures, promoting meat fermentation (Papamanoli E et al., 2003). Lactic acid bacteria improve safety and stability of the product, enhance colour stability, prevent rancidity and release various aromatic substances (Coppola R et al., 1998; Papamanoli E et al., 2003; Hammes WP et al., 1995; Nychas GJE, Arkoudelos JS, 1990). Dry fermented sausages, starter proteases play an important role on proteolysis. Proteolysis contributes to the consistency of the product by the degradation of the myofibrillar structure and to its taste through the accumulation of small peptides and free amino acids. These amino acids directly contribute to flavor or indirectly as precursors of flavor compounds through amino acid degradation reactions (Toldra F, Flores M, 1998; Ahmad S, Amer B, 2013).

IV. Conclusion

Small size broken shrimp meat is an excellent source of dietary protein. Bronze featherback (*Notopterus notopterus*) is an important freshwater fish in economic value of Vietnam. It is commonly sold in the form of scraped meat in plastic bags and kept on ice during transportation and distribution. We have successfully combined small size broken shrimp meat with bronze featherback (*Notopterus notopterus*) to create a new dry fermented sausage.

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