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Influence of different elements to the fermented *Pangasius hypophthalmus* sausage stability

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Abstract
With the purpose of sausage-product diversification from *Pangasius hypophthalmus*, a popular raw material source in Mekong river, Vietnam; we investigate the influence of different elements to the fermented *Pangasius hypophthalmus* sausage stability such as meat: fat ratio, starch supplementation, grinding time, polyphosphate addition, temperature and time of steaming. In order to get the best sausage quality, *Pangasius hypophthalmus* meat must be frozen at least 24 hours; ratio of fish meat: fat 75%: 25%; preservation of paste before grinding in 0-2 ^{o}C to avoid water detachment; gluten supplementation 1.5%, polyphosphate 0.4%, steaming in 70-75 ^{o}C within 90 minutes and cooling immediately to maintain firm structure.

Keywords: Pangasius hypophthalmus, diversification, fermented sausage, stability

1. Introduction
Buffaloes Vietnam has vast fish source with more than 2000 species, Fish is an important food for human consumption. Fish is a high protein food consumed by a large percentage of populace because of its high palatability, low cholesterol and tender flesh (Monalisa, K *et al*., 2013). *Pangasius* is a term used for a special variety of imported freshwater fish that have become the tenth most popular seafood product eaten in the United States. Consumers are eating about 6 ounces of *Pangasius* per year and demand for this moderately priced selection is expected to continue to increase. It is a primary example of the increasing demand and dependence on aquaculture or farm raised seafood products. *Pangasius bocourti* Sauvage, 1880 and *Pangasius hypophthalmus* Sauvage, 1887 are two indigenous fish species living in the Mekong River (Roberts & Vidthayanon, 1991). *Pangasius hypophthalmus* is one of the major fish species in the Mekong River fishery, one of the largest and most important inland fisheries in the world. The traditional development of capture-based aquaculture for this species, particularly in Viet Nam, probably began because it is a prolific spawner, producing relatively large numbers of larvae that are easily harvested from the flowing river. *Pangasius* species have a low to moderate fat content with high levels of protein. The amount and composition of the fat content will be influenced by the feed used in aquaculture operations. A nutrition label for a four ounce raw portion of *Pangasius* is provided. The actual nutrient content of products that are consumed will be affected by added ingredients and the cooking method that is used.
Sausage is one kind of fast food suitable for industrial modern society because of its high protein content, minerals Zn, Fe, Vitamin B, acid folic. Fish sausage is nutritious food having high energy and easy metabolism. There are many researches mentioned to *Pangasius hypophthalmus* sausage (L. C. Medeiros *et al*., 1985; Nongnuch Raksakulthai *et al*., 2004; Abdullah Oksuz *et al*., 2008); Xiao Qing Ren *et al*., 2011; Ananya Simmalee *et al*., 2013; Happy Nursyam *et al*., 2013; Anh Ngoc Tong Thi *et al*., 2013; Sovann Kin *et al*., 2013). Our study focuses on investigation of different factors influencing to the fermented *Pangasius hypophthalmus* sausage stability.

2. Material and Method
2.1 Material
Live raw *Pangasius hypophthalmus* are purchased in weight 1.4 ÷ 1.5 kg in Tra Vinh province.

2.2 Research method
2.2.1 Experiment #1: Effect of fish meat: fat to a stable emulsification
Live *Pangasius* raw fish are filleted, weighed and frozen 24 hours before processing. We prepare some additives as follows: 4% starch, 1.5% gluten 0.5% tripolyphosphate, 2% salt, 0.25% sodium glutamate, 0.6% sugar, 1.5% pepper, 2% garlic.

After preparation, fish meat and fat are grinded together with additives (except starch and gluten). Minced paste is then mixed with starch and gluten; kept in refrigerator 0-2 ^{o}C; grinded 2nd in 1 minute. Stuff the paste into intestine, steam at 75÷80 ^{o}C in 90 minutes. Testing parameters include moisture of paste and sausage; recovery; shear of product; sensory of product structure.

Fig 1: *Pangasius hypophthalmus*

2.2.2 Experiment #2: Effect of starch supplementation to sausage structure

After experiment #1, we choose the appropriated ratio of fish meat: fat. Then we prepare samples and freeze them in 24 hours. Additives are used as experiment #1, but changed starch ratio: 1%, 2%, 3%, 4%. Processing handling is executed as in experiment #1, grinded 2nd in 1 minute, steamed at 75 ÷ 80 ^{o}C in 90 minutes. Testing parameters include moisture of paste and sausage; recovery; shear of product; sensory of product structure.

2.2.3 Experiment #3: Effect of grinding time to sausage structure

We prepare raw material, additive and ingredient as experiments above. The 2nd grinding is performed in four time intervals. Then we measure sausage core temperature after fine grinding. Testing parameters include moisture of paste and sausage; recovery; shear of product; sensory of product structure.

2.2.4 Experiment #4: Effect of polyphosphate supplementation to sausage structure

We prepare raw material, additive and ingredient as experiments above. Tripolyphosphate is examined at four levels. Processing handling is executed as in above experiments; steamed at 75 ÷ 80 ^{o}C in 90 minutes. Testing parameters include moisture of paste and sausage; recovery; shear of product, sensory of product structure.

2.2.5 Experiment #5: Effect of steaming temperature and time to sausage structure

We prepare raw material, additive and ingredient as experiments above. Sausage is stuffed into intestine, steamed in different times and temperatures. Testing parameters include moisture of paste and sausage; recovery; shear of product, sensory of product structure.

2.3 Statistical analyses

Use Microsoft Excel 2003 at 95% confidence level.

3. Result and Discussion

3.1 Effect of fish meat: fat to sausage structure

Table 1: Effect of fish meat: fat to moisture of paste, moisture of sausage and recovery

Sample	Fish meat: Fat (%)	Paste moisture (%)	Sausage moisture (%)	Recovery (%)
1	80:20	42.87	42.66	96.11
2	75:25	52.77	52.56	97.29
3	70:30	49.00	48.33	95.17
4	65:35	52.68	50.98	96.93
5	60:40	48.16	46.59	97.42

Table 2: Effect of fish meat: fat to sausage structure

Sample	Fish meat: Fat (%)	Strain	Stress (kPa)
1	80:20	2.10^{b}	48.16^{bc}
2	75:25	2.25^{a}	75.78^{a}
3	70:30	2.10^{b}	55.63^{b}
4	65:35	2.11^{b}	48.46^{b}
5	60:40	2.14^{b}	35.43^{c}

Table 3: Sensory evaluation for sausage structure

Sample	Fish meat: Fat (%)	Structure
1	80:20	Soft, less strain, rather fine and not uniformed
2	75:25	Strain, soft, fine and uniformed
3	70:30	Strain, less fine, less uniformed
4	65:35	Strain, less fine, uniformed
5	60:40	Strain, fine, less uniformed

From above tables, we choose fish meat: fat = 75:25 for further examinations.

3.2 Effect of starch supplementation to sausage structure

Table 4: Effect of starch ratio to moisture of paste, moisture of sausage and recovery

Sample	Starch ratio (%)	Paste moisture (%)	Sausage moisture (%)	Recovery (%)
1	0	56.56	53.99	92.87
2	1	55.14	52.02	94.00
3	2	55.57	54.80	94.20
4	3	55.85	55.25	95.38
5	4	57.42	54.52	94.40

Table 5: Effect of starch ratio to sausage structure

Sample	Starch ratio (%)	Strain	Stress (kPa)
1	0	2.14^{c}	44.28^{b}
2	1	2.21^{abc}	61.04^{a}
3	2	2.17^{bc}	57.87^{a}
4	3	2.22^{ab}	61.86^{a}
5	4	2.25^{a}	62.48^{a}

Table 6: Sensory evaluation for sausage structure

Sample	Starch ratio (%)	Structure
1	0	Less strain, rather fine, soft, not uniformed, dark
2	1	Strain, fine, soft, less uniformed, light yellow
3	2	Strain, less fine, soft, uniformed, white
4	3	Strain, fine, soft, uniformed, white
5	4	Strain, fine, hard, uniformed, white

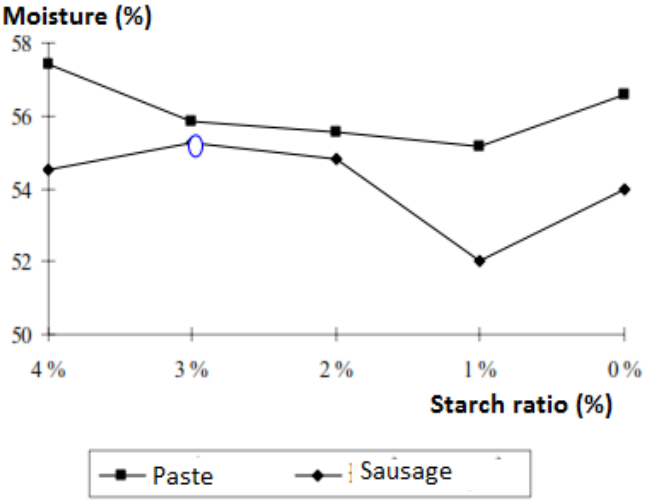

Fig 2: Moisture content by starch supplementation

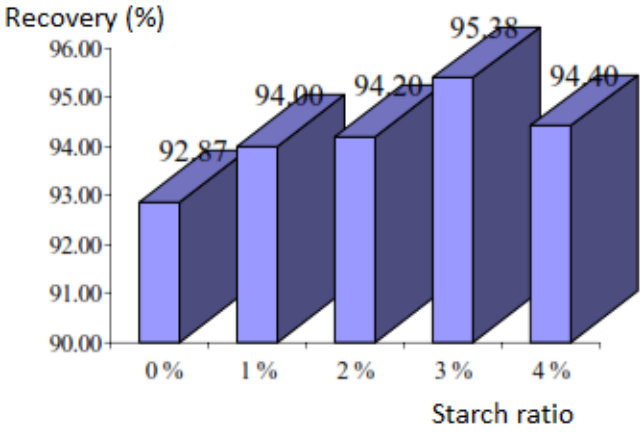

Fig 3: Sausage recovery by starch ratio

3.3 Effect of grinding time to sausage structure

Table 7: Effect of grinding time to moisture of paste, moisture of sausage and recovery

Sample	Grinding time (minutes)	Paste moisture (%)	Sausage moisture (%)	Recovery (%)
1	0.5	53.45	52.70	97.67
2	1.0	56.14	54.21	98.02
3	1.5	54.00	52.87	97.82
4	2.0	54.26	53.45	96.87

Table 8: Effect of grinding time to sausage structure

Sample	Grinding time (%)	Strain	Stress (kPa)
1	0.5	2.15^{a}	30.74^{b}
2	1.0	2.21^{a}	44.34^{a}
3	1.5	2.18^{a}	40.97^{a}
4	2.0	2.20^{a}	44.09^{a}

Table 9: Sensory evaluation for sausage structure

Sample	Grinding time (minutes)	Structure
1	0.5	Less strain, not fine, soft, not uniformed
2	1.0	Strain, fine, soft, uniformed
3	1.5	Strain, fine, hard, uniformed
4	2.0	Strain, fine, hard, uniformed

Table 10: Paste temperature by grinding time

Sample	Grinding time (minutes)	Temperature before grinding (ºC)	Temperature after grinding (ºC)
1	0.5	0-4	10.6
2	1.0	0-4	18.0
3	1.5	0-4	18.7
4	2.0	0-4	25.5

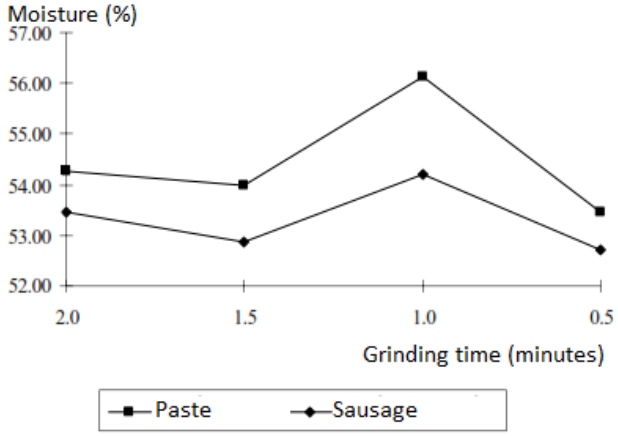

Fig 4: Moisture fluctuation by fine grinding time

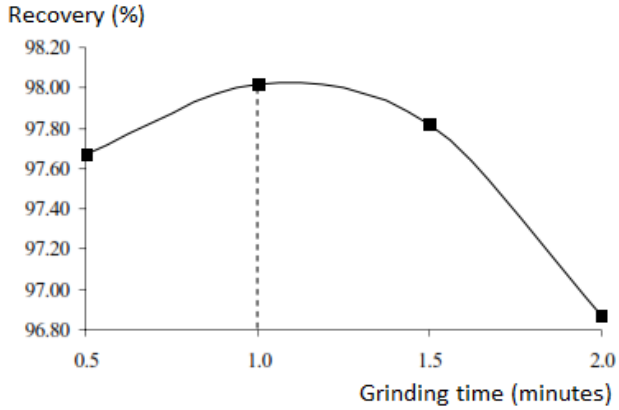

Fig 5: Recovery by fine grinding time

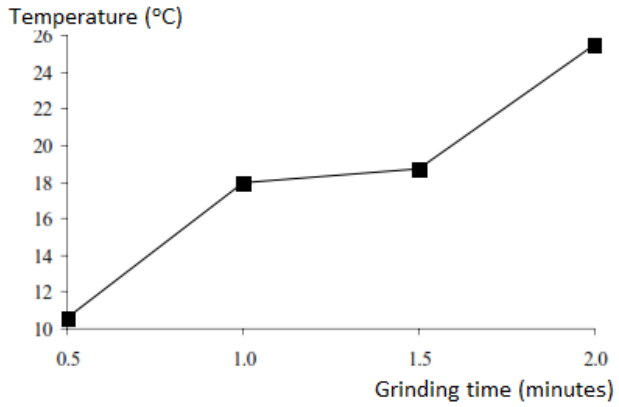

Fig 6: Paste temperature by grinding time

From above results, we choose paste grinding time 1 minute for further experiments.

3.4 Effect of polyphosphate supplementation to sausage structure

Table 11: Effect of polyphosphate supplementation to moisture of paste, moisture of sausage and recovery

Sample	Polyphosphate (%)	Paste moisture (%)	Sausage moisture (%)	Recovery (%)
1	0.3	48.75	47.59	98.35
2	0.4	55.84	55.35	98.39
3	0.5	53.78	53.16	98.21
4	0.6	48.70	48.17	97.64

Table 12: Effect of polyphosphate supplementation to sausage structure

Sample	Polyphosphate (%)	Strain	Stress (kPa)
1	0.3	2.15^{c}	30.74^{c}
2	0.4	2.21^{a}	44.34^{a}
3	0.5	2.18^{bc}	40.97^{b}
4	0.6	2.20^{ab}	44.09^{a}

Table 13: Sensory evaluation for sausage structure

Sample	Polyphosphate (%)	Structure
1	0.3	Less strain, liess fine, soft, not uniformed
2	0.4	Strain, fine, soft, uniformed
3	0.5	Strain, fine, soft, less uniformed
4	0.6	Strain, fine, soft, uniformed, strange flavour

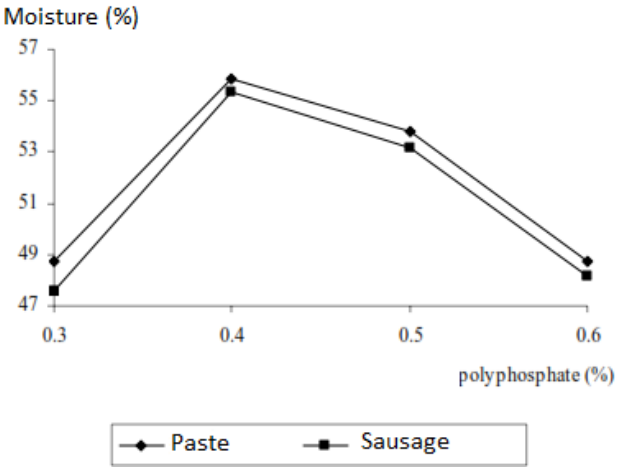

Fig 7: Paste moisture by polyphosphate supplementation

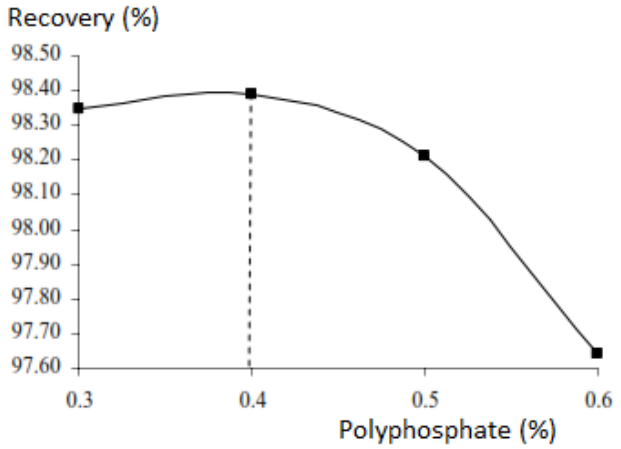

Fig 8: Recovery by polyphosphate supplementation

From above results, polyphosphate 0.4% is adequate for sausage production with good structure and high recovery.

3.5 Effect of steaming temperature and time to sausage structure

Table 14: Effect of steaming to sausage moisture content

Time / Temperature	90 minutes	100 minutes	110 minutes
65-70 ºC	54.66	54.70	55.42
70-75 ºC	55.36	53.71	52.26
75-80 ºC	52.16	52.36	52.06

Table 15: Effect of steaming to sausage recovery

Time / Temperature	90 minutes	100 minutes	110 minutes
65-70 ºC	95.45	95.09	94.01
70-75 ºC	95.98	93.87	93.73
75-80 ºC	94.35	93.53	93.49

Table 16: Effect of steaming to sausage structure

Time	90 minutes		100 minutes		110 minutes	
Tem-perature	**Strain**	**Stress**	**Strain**	**Stress**	**Strain**	**Stress**
65-70 ºC	2.14^{a}	51.68^{bc}	2.16^{a}	52.89^{abc}	2.19^{a}	54.31^{abc}
70-75 ºC	2.20^{a}	57.45^{a}	2.16^{a}	55.65^{ab}	2.14^{a}	51.72^{bc}
75-80 ºC	2.18^{a}	50.54^{c}	2.18^{a}	54.01^{abc}	2.14^{a}	53.02^{abc}

Table 17: Sensory evaluation for sausage product

Temperature (ºC)	Time (minutes)	Remarks
65-70 ºC	**90**	Soft, not strain, not uniformed, one part of starch uncooked, heavy fishy smell
	100	Soft, strain, quite uniformed, one part of starch uncooked, slight fishy smell
	110	Soft, less strain, uniformed, one part of starch uncooked, special product flavour
70-75 ºC	**90**	Soft, strong strain, white, uniformed, starch cooked completely, attractive flavour, white
	100	Soft, strain, white, quite uniformed, fatty on surface, special product flavour
	110	Soft, strain, white, uniformed, fatty on surface, special product flavour
75-80 ºC	**90**	Soft, less strain, uniformed, fatty on surface, special product flavour
	100	Soft, strain, uniformed, fatty on surface, special product flavour
	110	Soft, not strain, quite uniformed, fatty on surface, loose special flavour

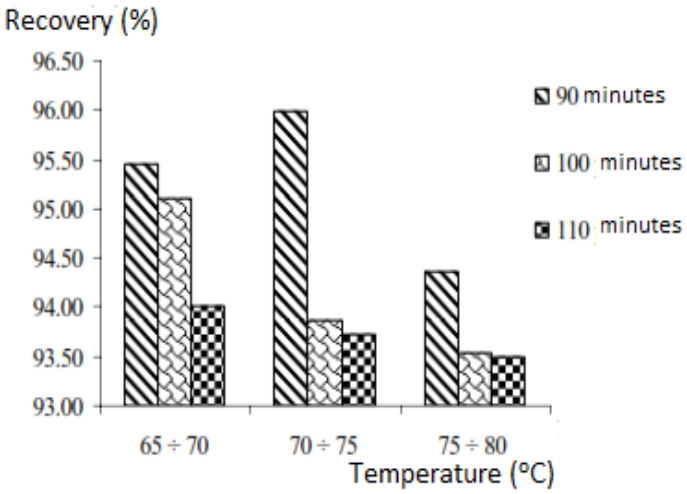

Fig 9: Sausage recovery by steaming temperature and time

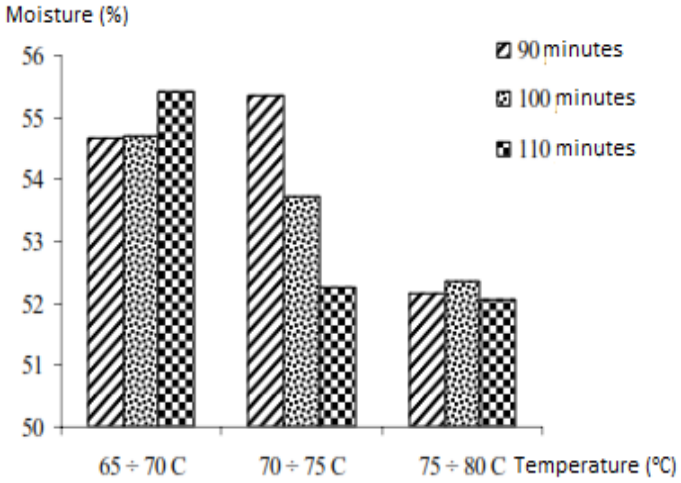

Fig 10: Sausage moisture by steaming temperature and time

Looking into table 16, sausage has good structure (strain and stress), high moisture, high recovery and special flavour at steaming temperature 70 ÷ 75 ºC in 90 minutes

3.6 Nutrient compositions in *Pangasius* fillet and fermented sausage

Protein and lipid content in *Pangasius* sausage are higher than in its raw fillet owing to a combination of fish and wheat (gluten). Because of its high moisture content and pH, it's quickly deteriorated by microorganism so it must be preserved in refrigeration.

Table 18: Nutrient compositions in *Pangasius* fillet and fermented sausage

	***Pangasius* fillet**	***Pangasius* sausage**
pH	6.2-7.4	6.32-6.48
Moisture (%)	62-70	52-59
Total protein (%)	17.2	17.9
Lipid	4.12	14.25

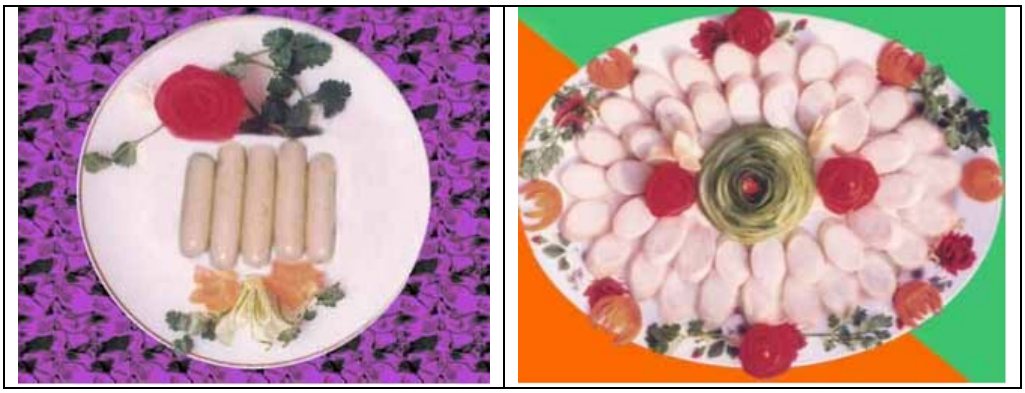

Fig 11: *Pangasius* sausage in whole trunk, and sliced form

4. Conclusion

It's necessary to control factors affecting to sausage quality. Best control will create high sensory value for human consumption. This research contributes to diversification of *Pangasius* products or utilization of its by-products. Our study has found out optimal ratio of fish meat: fat, additives (polyphosphate, starch), grinding and steaming to improve product structure. This is a foundation to completely establish a *Pangasius* sausage protocol.

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