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INVESTIGATION ON THE OPTIMUM CONDITIONS IN PEDAH PROCESSING *

PENENTUAN KONDISI OPTIMUM PADA PENGOLAHAN PEDAH*

*Hari Eko Irianto and John D. Brooks***

ABSTRACT: *Pedah is one of the Indonesian traditional fermented fish products. This product has a unique specific characteristic. In this work, the effects of various processing variables were studied. Yelloweye mullet (Aldrichetta forsterii) was used as raw material. The processing variables studied were the length of the salting period (3 and 7 days), salt addition during maturation process (with and without salt addition) and maturation period (0, 4, 8 and 12 weeks). The product were analyzed chemically, microbiologically and organoleptically. Chemical analyses indicated that chemic changes still occurred until 8 weeks maturation period and further maturation period would give relatively constant values for those parameters. The growth of halophilic, lipolytic, and proteolytic bacteria decreased during maturation process. Sensory evaluation revealed that organoleptically, the best pedah could be obtained by three day salting period and without salt addition during maturation process. This study suggested that maturation process should not be run for more than four weeks.*

ABSTRAK: Pedah merupakan salah satu produk fermentasi ikan tradisional Indonesia yang mempunyai karakteristik spesifik. Di dalam penelitian ini dipelajari pengaruh berbagai variabel pengolahan pedah yaitu lama penggaraman (3 dan 7 hari), penambahan garam selama tahap pematangan (fermentasi) dan lama fermentasi (0, 4, 8 dan 12 minggu). Produk yang diperoleh dianalisa secara kimiawi, mikrobiologi dan organoleptik. Analisa kimia menunjukkan bahwa perubahan- perubahan kimia masih terjadi selama proses fermentasi sampai minggu ke delapan dan proses fermentasi lebih lanjut akan memberikan nilai yang relatif konstan terhadap parameter-parameter kimiawi yang dianalisa. Pertumbuhan bakteri halofilik, lipolitik dan proteolitik menurun selama proses fermentasi. Hasil analisa organoleptik menunjukkan bahwa produk yang terbaik adalah diperoleh dengan lama penggaraman 3 hari dan tanpa penambahan garam selama proses fermentasi. Penelitian ini merekomendasikan untuk tidak melakukan proses fermentasi lebih dari 4 minggu.

1. INTRODUCTION

One of the traditional fish processing methods is fermentation and there are many kinds of fermented fish products which can be found in Indonesia. The most popular fermented fish products in Indonesia are terasi (fermented fish or shrimp paste), pedah (moist salted fish), kecap ikan (fish sauce) and jambal roti (moist salted split fish). Some other fermented fish products are *bakasang* from South Kalimantan, *bekasam* from South Sumatera and *picungan* from Banten, West-Jawa. These products have special consumers in Indonesia, since they are able to provide specific unique characteristics (Irianto, 1990).

Pedah is quite different from other fermented fish products, especially the flavour and texture.

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Basic method of pedah processing is a salting process with two salting steps. The first salting step is normally carried out for several days. On the other hand, the second salting step takes several weeks to develop its characteristic flavour and texture, and this step is called as maturation phase. However Hanafiah (1987) noted that there is no prescribed period for the processing, the length of which varies from processor to processor.

The objective of this study was to reveal the behaviour of pedah during processing in both during salting and maturation periods with respect to chemical, microbiological, and organoleptic changes. Information obtained was used to determine the optimum condition of pedah processing.

2. MATERIALS AND METHODS

2.1. Materials

Yelloweye mullet used for the raw material in this study had total length of 27.4±1.1 cm, thickness of 3.2±0.2 cm and weight of 182.64±21.55 g. The proximate analysis showed that moisture, protein, fat and ash contents of the fish were 78.02%, 15.53% (w.w.), 4.47% (w.w.) and 1.05% (w.w.) respectively. The pH and salt content of the fish were 6.73 and 0.85 percent (w.w.) respectively. The purity of salt used was 94.84%.

2.2. Methods

2.2.1. Experimental Design

In this experiment, all conditions were maintained constant except for three factors:

1. First fermentation period (A):
   - (A_1) three days
   - (A_2) seven days

2. Salt addition in the second fermentation (B):
   - (B_1) without salt
   - (B_2) with salt

3. Second fermentation period (C):
   - (C_1) 0 weeks
   - (C_2) 4 weeks
   - (C_3) 8 weeks
   - (C_4) 12 weeks

A factorial design was used, yielding 16 sample units. Since the experiment was run in two replications, a 32 sample total was tested. Results were analyzed using a factorial complete randomized design. The T-test was used to differentiate the average significance levels within the treatments and the interaction between the treatments.

2.2.2. Pedah Processing

The main stages of pedah processing in the experiment were fish preparation, salting, draining and maturation.

a. Fish Preparation

Fish were received in chilled condition in styrofoam boxes. Fish were then washed with running water and placed in plastic bags with three or four pieces for each bag. The plastic bags were arranged in stainless steel containers and stored at -25°C until ready for use. Fish were taken out of the freezer and thawed at room temperature before using them. During thawing, the water was run continuously until the individual fish were separated and its texture was back to normal. The thawing period was around two hours. The fish were then sorted to obtained homogeneous freshness and size.

b. Salting

The fish were salted using a 1 : 3 salt to fish ratio. Fish and salt were arranged in layers alternately in a plastic vat, in which thick layers of salt were added at the bottom and on the top layers to keep the saturated condition of brine, especially when the fish start releasing water. The salting process was carried out in an incubator at 28 - 31°C for two determined periods, i.e. three days and seven days. By the end of the process, the fish were soaked in saturated brine pickle with coarse salt remain at the bottom and the top covering the fish.

c. Draining

After salting, excess salt was removed from fish by washing with the brine from the salting process and draining for three hours. Draining is done to facilitate the fish for the next process, because the excess water will disturb the second fermentation. Draining was conducted by leaving the fish on trays at ambient temperature for about an hour.

d. Maturation

The fish were divided into two lots, one lot was for maturation without salt addition and another lot for maturation with salt addition. In the maturation, the fish were put in the plain polytene bags. Air inside the bags was minimized and then bags were heat sealed. For the maturation with salt addition, salt was added amounting to as much as an one third of fish weight. This was thoroughly mixed with the fish, so that the fish were entirely covered with salt. The fermentation was performed in the incubator at 28 - 31°C for over 12 weeks.

Observations were carried out at four week intervals starting from the time the fish were placed in the incubator. When taking samples with salt addition treatment, the salt on the surface of the fish was removed manually before the observation.

2.2.3. Analysis

During the maturation period, the fish were analyzed chemically, microbiologically and organoleptically. The chemical analyses consists of moisture and salt contents (AOAC, 1984), pH (Irianto, 1990) and water activity (a_w). The microbiological analysis consisted of halophilic bacteria (Baross, 1976), lipolytic bacteria and proteolytic bacteria (Fardiaz, 1987). A preference test method, using a nine-point hedonic scale, was chosen to evaluate the sensory quality of pedah. Eight panellists took part in the evaluation, six of them were Indonesians and two others were a Thai and a Filipino. They were chosen, since they normally consumed salted fish in their countries.

3. RESULTS AND DISCUSSION

Results of analysis of variance and significant effects of all tested factors on each parameter can be seen in appendix 1.

3.1. Chemical Changes in Pedah During Maturation Process

Results of chemical analyses of pedah through maturation process can be seen in Table 1.

Table 1. Chemical Changes in Pedah During Maturation Process

Salting Periode	Salt addition During Maturation	Maturation Period (weeks)	Moisture Content (%)	Salt Content (%)	a_w	pH
3 days	Without Salt	0	58.28	14.84	0.825	6.60
		4	53.45	15.79	0.782	6.27
		8	53.32	19.18	0.775	6.23
		12	54.06	18.99	0.768	6.22
	With Salt	0	58.28	14.84	0.825	6.6
		4	51.31	17.24	0.762	6.17
		8	51.85	19.55	0.77	6.25
		12	51.28	20.57	0.76	6.28
7 days	Without Salt	0	53.77	18.66	0.76	6.46
		4	53.65	18.16	0.768	6.34
		8	53.43	19.74	0.77	6.23
		12	52.7	19.68	0.763	6.17
	With Salt	0	53.77	18.66	0.764	6.46
		4	53.7	18.47	0.77	6.31
		8	52.74	20.11	0.77	6.09
		12	51.72	20.62	0.762	6.08

3.1.1. Moisture Content

According to analysis of variance, moisture content seemed to show significant responses to all factors used in this experiment. Statistical analysis showed that the longer salting period significantly lead to lower moisture content of pedah. This is the common phenomenon in salting process as has been reviewed by Stansby (1963), Burgess et al (1965) Vonskresensky (1965) and van Klaveren et al (1965). Likewise, the maturation time showed a trend towards the reduction of moisture content. Similarly, salt addition in the maturation process markedly decreased the moisture content of pedah (Appendix 1). Moisture content of pedah salted for 3 days and added with salt during maturation slightly increased at the end of the study, but this increment was statistically insignificant.

Dehydration in pedah was apparently affected by the interaction of length of the salting period and salt addition in the maturation. The lowest dehydration occurred in the pedah fermented for three days in the salting and without salt addition in the maturation process.

Interaction of the salt addition in the maturation process and the maturation period exhibited pronounced effect on the moisture content of pedah. The moisture content of both pedah with and without salt addition during maturation process was relatively constant after four week maturation, but the moisture content of pedah with salt addition decreased again at the end of maturation process. This decrease might be due to drying process occurred on the surface of fish and then induced the movement of water from inside to the surface of the fish.

The interaction of the salting period and the maturation period showed a significant effect on the moisture content of pedah as well. The moisture content of pedah fermented for three days in the salting process decreased until four week maturation. The moisture content of pedah salted for seven days remained practically constant during the first eight week of maturation process, and then decreased again at the twelfth week of maturation. A similar occurrence was also previously found as the effect of salt addition in the maturation process.

3.1.2 Salt Content

The salt content of the sample salted for three days was nearly the same as the result obtained by Hanafiah (1987) from Indian mackerel fermented for seven days, i.e. 14,1 percent. The sample salted for seven days had a salt content in the range of 16.98 to 20.64 percent as reported by Sjachri and Nur (1977) using mackerel fermented for seven days.

Analysis of variance revealed that all factors controlled in this study apparently affected the salt content of pedah. Salting time significantly influenced the salt content of pedah. The longer the salting period, the higher the salt content of pedah. This means that the contact time between the fish and the saturated brine apparently affected the salt content of final products before reaching saturation.

T-test showed that pedah which was maturated and covered with salt during the maturation process had a higher salt content compared with the pedah without salt covering (at 99% significant level). The maturation period also had an apparent effect on the general pattern of the salt content increment. The salt increment occurred until the eighth week of observation and then the salt content remained relatively constant.

The interaction of the salting period and the maturation period showed a pronounced effect on the salt content of pedah. The salt content of pedah made by salting for both three days and seven days increased until the eighth week of the maturation process, but the pedah treated with a seven day-salting had higher salt content than pedah salted for three days.

3.1.3. Water Activity

Statistical analysis revealed that significant change in moisture content was not always followed by a significant change in water activity. This fact was supported by sorption isotherm curves described by Acker (1969), Fellows (1988) and McKay (1989).

The water activity of pedah was strongly influenced by salting period and the salt addition in the maturation process. The a_w of pedah was apparently affected by the salting time. Pedah with a three day-salting obviously had higher average value of a_w (0.783) than those of a seven day-salting (0.765). This gave an interpretation that a longer salting period will result to a lower a_w of the product. The same effect was exhibited by salt addition during the maturation period. The salt addition significantly decreased the a_w value; in which the a_w of the product without salt addition (0.777) was higher than that of the product with salt addition (0.770).

The maturation period significantly affected the a_w in the products. The a_w reduced until the fourth week of the maturation period from 0.795 at the beginning of the maturation process to 0.770 at the fourth week. After this, further maturation period had no significant effect on the a_w value.

The a_w value of pedah during processing was markedly influenced by the interaction of length of the salting and the salt addition in the maturation process. The lowest a_w value occurred in the pedah salted for seven days with or without salt addition in the maturation process. This means that the salt addition in the maturation process did not affect the a_w of pedah fermented for seven days during the salting process. On the other hand, the highest a_w value was encountered in the pedah salted for three days without salt addition in the maturation process.

Interaction of the salting period and the maturation period significantly affected the a_w of pedah. Only pedah treated with a three day-salting expressed a_w changes during the maturation process, in which the changes occurred until the fourth week of the maturation. Pedah salted for seven days had a_w values which were relatively constant during the maturation.

3.1.4. pH

The salting and maturation periods obviously affected the pH value of the product during the maturation process. The salt addition in the maturation seemed to have no effect on the pH of pedah. In this case, pedah salted for seven days had a slightly higher acidity value compared with that salted for three days, since the former pedah had the pH of 6.32 and the later had the pH of 6.27.

The effect of the maturation period on the pH value of pedah was significant. In general, the pH value of pedah decreased during the maturation process. The pH reduction in pedah occurred until the eighth week of maturation, from 6.53 to 6.20. After this period, there was relatively no change in the pH values. Base formation might counteract acid formed during fermentation process and this induced the constant pH values.

The pH value of pedah was significantly affected by the interaction of the salting period and the maturation period. During the maturation period, pedah processed with a seven day-salting, generally tended to have lower pH than pedah salted for three days. The pH value of pedah with a three day-salting decreased significantly until the fourth week of the maturation, subsequently there were no significant changes in pH. Pedah salted for seven days increased in acidity until the eight week of the maturation and further maturation had no effect on the pH.

3.2. Microbiological Changes in Pedah During Maturation Process

The results of microbiological analyses of pedah during maturation process can be seen in table 2.

3.2.1 Halophilic Bacterial Growth

The only factor affecting the halophilic bacterial growth was the length of the maturation period.

The halophilic bacterial growth decreased until the eight week of the maturation and then increased at the twelfth week. However, in the pedah which were salted for three days and with salt addition in the maturation, the halophilic bacteria disappeared at the twelfth week of the maturation. Although statistically the salt addition did not affect the halophilic bacterial growth, the results indicated that the addition of salt during the maturation enhanced the halophilic bacterial growth.

Table 2. Microbiological Changes in Pedah During Maturation Process (log cfu)

Salting Period	Salt Addition During Maturation	Maturation Period (weeks)	Halophilic Bacteria	Lipolytic Bacteria	Proteolytic Bacteria
3 days	Without Salt	0	2.142	3.773	3.647
		4	1.000	1.778	1.15
		8	0.500	1.24	0
		12	1.81	1.87	0
	With Salt	0	2.142	3.773	3.647
		4	2.76	1.986	2.050
		8	1.54	1.602	0
		12	0.000	0	0
7 days	Without Salt	0	2.986	3.599	3.303
		4	1.151	2.046	1.812
		8	0.500	0.500	0
		12	1.088	1.540	0
	With Salt	0	2.986	3.599	3.303
		4	1.866	2.305	2.050
		8	0.500	1.739	0
		12	2.202	1.557	0

3.2.2 Lipolytic Bacterial Growth

An analysis of variance on lipolytic bacterial growth in pedah revealed that the lipolytic bacterial growth was significantly influenced by the factors of the maturation period.

Eventhough statistically the salt addition in the maturation did not affect the lipolytic bacterial growth, the results indicated the differences of pattern of lipolytic bacterial growth in pedah with and without salt addition. In the pedah with salt addition in the maturation process, the lipolytic bacterial number tended to decrease during maturation, and in the pedah salted for three days, the lipolytic bacteria had died completely off by the twelfth week. In the pedah without salt addition in the maturation, the lipolytic bacteria decreased until the eighth week of the maturation and then increased at the twelfth week.

3.2.3. Proteolytic Bacterial Growth

As with the halophilic and lipolytic bacterial growths, statistically the maturation period was the only factor giving a significant influence to the growth of proteolytic bacteria. The number of proteolytic bacteria decreased continuously during the maturation and none of the proteolytic bacteria was found in any samples after the eighth week of maturation.

3.3. Organoleptic Changes in Peda During Maturation Process

The results of sensory evaluation for appearance, odour, taste and texture of pedah through maturation process are shown in table 3.

Table 3. Organoleptic Changes in Pedah During Maturation Process (a nine point hedonic scale)

Salting Period	Salt Addition During Maturation	Maturation Period (weeks)	Appearance	Odour	Taste	Texture
3 days	Without Salt	0	6.84	6.78	6.39	6.89
		4	7.22	7.11	6.56	7.22
		8	7.07	6.94	6.69	6.94
		12	6.63	6.76	6.13	6.82
	With Salt	0	6.84	6.78	6.39	6.89
		4	7.22	7.11	6.56	7.22
		8	6.01	6.88	6.51	6.94
		12	6.44	6.8	6.38	6.75
7 days	With Salt	0	6.44	6.89	6.17	6.73
		4	5.89	6.84	7.11	6.56
		8	5.94	6.63	6.32	6.26
		12	6.26	6.75	6.07	6.69
	With Salt	0	6.44	6.89	6.17	6.73
		4	7.33	7.06	6.50	7.17
		8	6.01	6.69	6.44	6.94
		12	6.57	7.00	6.13	6.88

3.3.1 Appearance

Panelists were able to distinguish the effect all factors examined in this study on the appearance of pedah.

Pedah salted for three days resulted in a better appearance than pedah salted for seven days. Salt addition in the maturation significantly affected the appearance of pedah. The presence of the coarse salt on the surface of fish which was difficult to remove completely, was probably the main cause of that occurrence..

In general, the appearance showed decreasing acceptability during the maturation. The appearance score decreased at the eighth week of maturation, and then increased again at the twelfth week. The changes in colour probably affected the perception of the panellists on the appearance score of pedah, especially the intensive brown colour as result of oxidation process (van Veen, 1953; 1965). The lowering of the appearance scores at the eighth week of maturation was also probably due to the normal physical damage which occurs such as bursting or damage in the bell part of pedah.

The interaction between the salting and the salt addition in the maturation significantly influenced the appearance of pedah. Pedah processed by salting for three days and without salt addition in the maturation showed the best appearance compared with the others. Pedah made by salting for three days as in the previous sample but with salt addition during the maturation, showed no significant difference in appearance from pedah salted for seven days, with or without salt addition in the maturation.

Until the final observation, the panelists still accepted the appearance of pedah.

3.3.2. Odour

Panelists were apparently unable to differentiate between the odour of pedah salted for three days and seven days and between pedah with and without salt added during the maturation. Likewise, the panelists could not detect any changes in odour during a 12 week-maturation.

All products still showed acceptable scores until the final experiment.

3.3.3. Taste

The only individual factor which did have a detectable effect on the taste of pedah was the maturation period. The maturation period and the salt addition in the maturation did not significantly affect the taste. All interactions had no significant influence on the taste.

The best taste of pedah was achieved at the fourth week of the maturation. After that time, the panelists gave lower taste scores, meaning that the prolongation of the maturation beyond four weeks was unnecessary in pedah making. All samples still had acceptable scores until the end of maturation.

Hanafiah (1987) noted that during the fermentation of pedah, the protein and lipid are broken down. The lipolytic bacteria may intensively break down the lipids to provide components contributing to the flavour of pedah. Haymon and Acton (1978) found that microorganisms are responsible for many types of flavours in meat products and the flavour compounds produced from the animal fats are directly responsible for the taste.

3.3.4. Texture

According to the panelists, no individual factor induced any significant difference in the texture of pedah. However, the texture scores showed response to interactions.

Interaction of the salting period and the salt addition in the maturation had a pronounced effect on the texture of pedah. The panelists gave a better score to the pedah salted for three days and without salt addition in the maturation; and to the pedah salted for seven days and with salt addition in the maturation process.

With regard to the interaction of the salting period and the maturation, generally the best texture was obtained at the fourth week of the maturation of product prepared by a seven day salting.

The texture of pedah during the maturation was apparently determined by the presence of salt in the maturation as well. The salt addition seemed to produce pedah with a stable texture after the eight week of maturation. However, the absence of salt increased the texture score of pedah at the fourth week of maturation and then decreased at the eighth week. Thus, the best texture of pedah made without salt addition, was achieved at the fourth week of maturation.

Interaction of all three factors had a significant effect on the texture of pedah. Pedah made with a three day-salting and without salt addition in the maturation and pedah processed by salting for seven days in the first fermentation and with salt addition in the maturation, resulted in a better texture.

The panelists still accepted the texture of all samples until the end of the experiment.

4. CONCLUSION

The experiment revealed that the length of salting and maturation periods apparently determined the moisture, salt contents, water activity and pH of pedah. All observed chemical parameters have achieved relatively constant values starting the eighth week of the maturation.

In general, the growth of halophilic, lipolytic and proteolytic bacteria was significantly affected by maturation period. The lipolytic bacteria might be the most important bacteria in pedah making and contributed to the development of pedah flavour.

On the basis of sensory scores, it is recommended that the salting treatment should not exceed three days. The maturation process should not be conducted for more than four weeks, since after this period the appearance and taste of pedah tend to decrease. The salt addition in the maturation process is unnecessary.

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Appendix 1. Factors in this experiment and their significant effects on parameter tested

Factors and their interaction	Chemical Analysis				Microbiological Analysis			Organoleptic Analysis			
	M.C	Salt Content	a_w	pH	Halophilic Bacteria	Lipolytic Bacteria	Proteolytic Bacteria	Apprearance	Odour	Taste	Tex-ture
Salting Period (A)	++	++	++	++	-	-	-	+	-	-	-
Salt Addition in Maturation (B)	++	++	++	-	-	-	-	++	-	-	-
Maturation Period (C)	++	++	++	++	++	++	++	+	-	+	-
Interaction:										-	++
A x B	++	-	++	-	-	-	-	++	-	-	++
B x C	++	+	-	-	-	-	-	++	-	-	+
A x C	++	++	++	++	-	-	-	-	-	-	+
A x B x C	-	-	-	-	-	-	-	-	-		

M.C.= moisture content

Note:

- = no significant effect at both 1 and 5 percent level
+ = significant effect at 5 percent level
++ = highly significant effect at 1 percent level