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The effect of mixture and size of fish food on the fish food qualities producing from the waste of agriculture and fishery

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Abstract

The remnant of fish and the bran are the waste in the community that earns one's living from the fishery in net cages. These wastes cause the cost of management and the pollution. Hence, this research studied the fish food production from the waste in the community using the pellet fish food (PFF) producing machine. The water content in fish food at the amount of 140, 160 and 180 g, the diameter size of 4 and 6 mm and the compression ratio (CR) of 2.5 and 3, and including the drying kinetic of PFF at drying temperature of 50ºC were also studied. The PFF qualities were estimated with the pellet durability index (PDI), the pelleting efficiency and the weight loss of PFF in water. Study results showed that the decreased trend of PDI value with the increment of the water content for every pellet size and the CR. The PDI value at the same pellet size increased with the enhanced CR due to the improvement of density within the pellet. The pellet size of 4 and 6 mm should be produced at the CR of 2.5 with the water content of 140 g and the CR of 3 with the water content of 160 g. Under the previous condition, the maximum value of pelleting efficiency was about 92-93%. For the CR in the range of 2.5 to 3, the percentage of weight loss of PFF was 14-27% and 16-26% for the pellet size of 4 mm and 6 mm, respectively. The PFF in this study spent the drying time around 3-6 hours for the moisture reduction approached the commercial pellet fish food.

Keywords: Pellet fish food, Compression ratio, Pellet durability, Pelleting efficiency

1. Introduction

The wastes of agriculture and fishery have many types such as the remnant of fish from the fishery and the bran from rice milling. These wastes caused the pollution and the payment for eradication. However, these rubbishes could recycle into the raw material for fish food production. This reuse will solve the pollution and decrease the expenditure for purchasing fish food. The artificial fish food have many advantages such as high stocking density and promoted the growth of fish due to the adequacy of nutritional content and fish food amount [1]. The fish food was produced in the pellet form. The pelleting of animal feed ameliorated competency in feeding and for convenience in feed administration. Behnke (1998) [2] explained that the many advantages obtained from pelleted feed such as the reduced feed wastage, diminished mixture separation and annihilation of the pathogen. The pellet qualities related to many factors, for instance, the ingredient, feed formulation, binder, particle size, production process and die specifications [3]. Lim and Cuzon (1994) [4] reported that the water stability of pellets could considerably improve by suitable selection of feed ingredients and processing techniques. Therefore, this research intended to investigate the effect of water content in ingredients, the CR, the pellet diameter size on the drying kinetic, the pellet durability, the pelleting efficiency and the weight loss of PFF in water.

2. Materials and methods

2.1 Preparation of fish food ingredient

The ingredient of fish food in this study consisted of a crushing fish 500 g and a rice bran 200 g that is the trash in the community; a corn flour 50 g; a fish oil 50 g; a molasses 50 g and the water. The water content was altered in 3 volumes namely 140, 160 and 180 g. All mixtures were homogeneously mixed and fed into the PFF producing machine.

2.2 Preparation of PFF

The machine as shown in Figure 1a used to produce the PFF as presented in Figure 1b. This machine used the rollers for the raw materials feed into the die holes to form the pellet. The CR in this study was 2.5 and 3 by it could obtain from the ratio of die thickness per die diameter (L/D). The pellet had the length about 10 mm. Then, The PFF was dried using the hot air oven at the temperature of 50°C. The moisture content of PFF was found at a predetermined time for the drying kinetic creation. Drying kinetic results presented by

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the average value of three repetitions. The proper moisture content after drying was referenced with the commercial PFF.

(a)

(b)

Figure 1 (a) The PFF producing machine and (b) the pellet fish food samples

2.3 PFF qualities

The qualities of PFF were evaluated regarding the pellet durability, the pelleting efficiency and the weight loss of PFF in water. The pellet durability showed in the form of the percentage of the PDI. The PDI value was measured with the method of ASAE standard S269.4 (2003) [5]. The pelleting efficiency was the ratio between the pellet mass per the fish food mass feed into the machine before the pellet formation. This ratio was multiplied by 100 to change into the percentage of pelleting efficiency. The weight loss of PFF in water showed the percentage of weight loss during the water soakage for 1, 2, 3, 4, 5 and 6 hours. All qualities results presented in the average value of three duplications.

3. Results and discussion

3.1 Pellet durability

Figure 2 showed that the effect of the CR, pellet diameter size and water content on the PDI values. These PDI values indicated the endurance of PFF. The pellet size of 6 mm had the maximum PDI value about 95% at the water content of 140 g with the CR of 3. The PDI value had the decreased trend with the increase of water content in every the diameter size and the CR, especially, the CR of 2.5 with the diameter size of 4 mm that clearly decreased. This result differenced from the result of Fairchild and Greer (1999) [6]. Their results showed the augmentation of PDI value with water addition in pellet animal food due to the occurrence of starch gelatinization after steaming and led to the connection between particles within the pellet. On the other hand, the hot air drying at the temperature of 50°C in this study that may not adequate for the happening of starch gelatinization. Hence, the space between particle had not a cohesive bridge and led to the diminution of PDI value. The increase of the CR caused the enlargement of PDI value due to the growing density of pellets [7]. However, the difference of pellet size in this study insignificantly affect the PDI value.

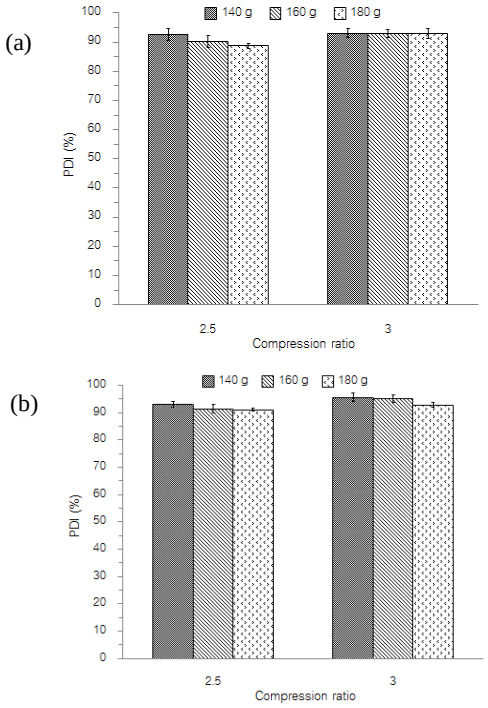

Figure 2 The percentage of PDI and the CR at the PFF diameter of (a) 4 mm and (b) 6 mm

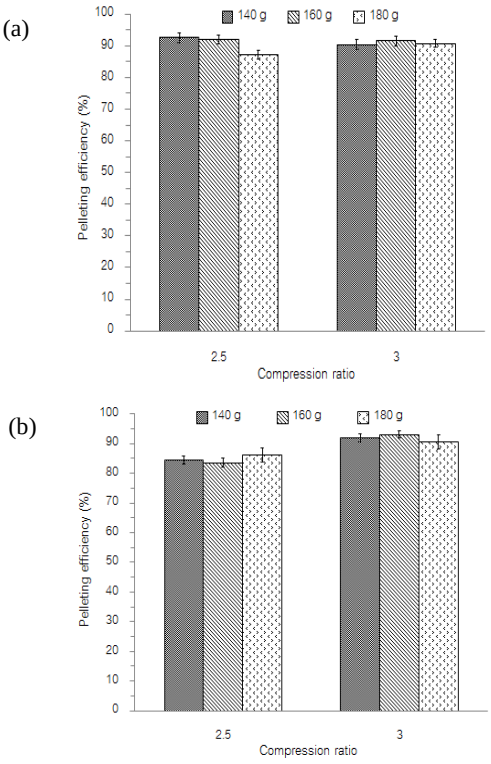

Figure 3 The pelleting efficiency at the pellet size of (a) 4 mm and (b) 6 mm

3.2 Pelleting efficiency

Pelleting efficiency represented the performance of the machine for the pellet formation. The pelleting efficiency did not significantly changed at the pellet diameter size of 4 mm for every the CR and the water proportion, excepting, the water content of 180 g with the CR of 2.5 as shown in Figure 3a. At the diameter size of 6 mm, the pelleting efficiency essentially increased when the CR increased for all water proportion as presented in Figure 3b. These results implied that the appropriate operating condition for the pellet formation. The CR of 2.5 with the water content of 140 g could give the maximum pelleting efficiency about 92% for the pellet size of 4 mm. In the same way, the CR of 3 with the water content of 160 g could cause the maximum pelleting efficiency about 93% for the pellet size of 6 mm.

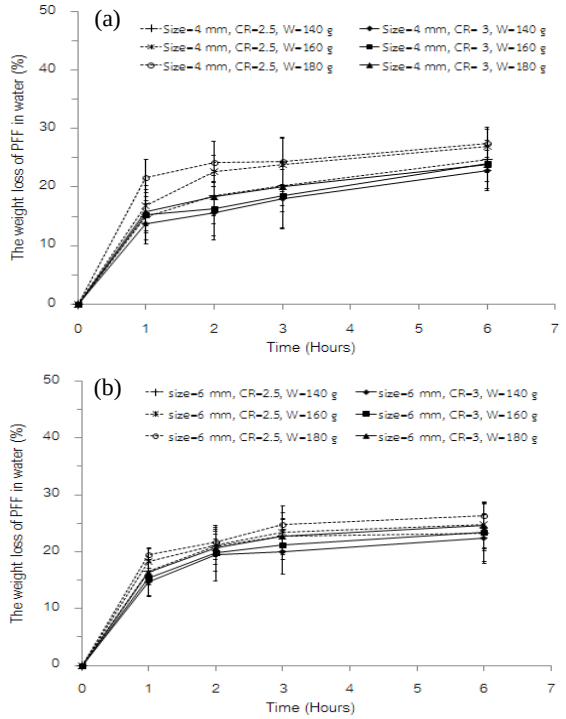

Figure 4 The weight loss of PFF in water at the pellet size of (a) 4 mm and (b) 6 mm

3.3 The weight loss of PFF in water

Figure 4 showed the percentage of PFF weight loss in water. This percentage revealed that the water durability of aquaculture feed. For 1-6 hours pellets stayed in the water, the weight loss increased with the soaking time. The weight loss had the reduced trend with the decrease of water content. The water content of 180 g with the CR of 2.5 caused the maximum weight loss about 27% for the pellet sizes of 4 mm. The weight loss diminished with the enlargement of the CR. The increased CR caused the elevated density. Thus, the water may hardly penetrate into a pellet and resulted in the loss of mass of pellet decreased. Furthermore, the reduction of pellet size caused the increase of the weight loss due to the increment of the contact area between water and pellet mass. The increased contact area led to the fluent mass transfer. The weight loss was in the range of 14-27% and 16-26% at the pellet diameter size of 4 and 6 mm as presented in Figure 4a and 4b, respectively. The weight loss of PFF depended on the type of binding aids. Boonyaratpalin (1981) [8] reported that the percentage of pellet weight loss in water obtained from the different pellet binding aid, i.e. broken mung bean, mung bean bran and yellow Alfa starch. Those binding aids were the agriculture products and resulted in the pellet weight loss in the range of 11.3-20.7%, 11-21% and 18-32%, respectively, at the pellet soakage for 1-6 hours. These results resembled with the results of PFF loss in this study that used the molasses for binding aid. In general, the weight loss of fish food should not more than 50% within 0.5 hours.

3.4 Drying kinetic of PFF

Figure 5 presented the drying kinetic of PFF for the hot air drying at the temperature of 50ºC. The final moisture content required around 3% (w.b.) which is the general moisture content in commercial pellet fish food. The study result found that the difference of water content in mixture caused the dissimilar initial water content in PFF as shown in Figure 5. The water content of 140 g spent the shortest drying time about 3 hours. However, the distinction of initial moisture content insignificantly affected the drying time as indicated by the similar drying period for 3-6 hours in every the CR, diameter size and water content.

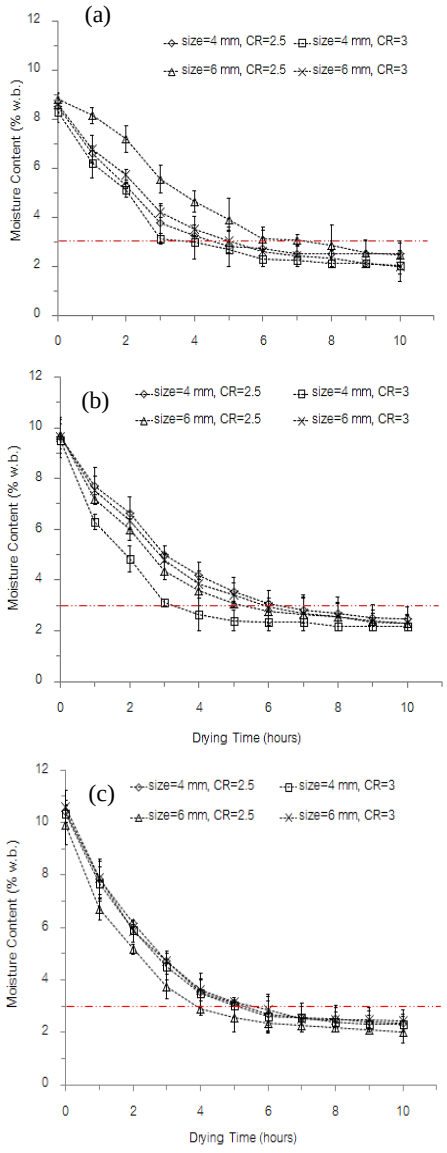

Figure 5 Drying kinetic of PFF with the water quantities of (a) 140 g (b) 160 g and (c) 180 g

4. Conclusions

The PFF at the diameter size of 4 and 6 mm that should be produced at the CR of 3 with the water content of 140 g. The pellet qualities obtained from the above condition that had the high pellet durability (greater than 90%) and the adequate pelleting efficiency (not less than 90%). Moreover, the qualities of the weight loss in water and the moisture content in PFF passed the acceptable criterion.

5. Acknowledgements

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6. References

[1] Bolorunduro PI. Feed formulation and feeding practices in fish culture. Fisheries Series No. 7, National Agricutural Extension and Research Liaison Services, Ahmadu Bello University, Zaria; 2002.
[2] Behnke KC. Why Pellet?. Proceedings Kansas State University/American Feed Industry Association Pellet Conference; 1998; Manhattan, USA.
[3] Behnke KC. Factors affecting pellet quality. In: Fahrenholz AC, Stark C, Jones C, editors. Feed pelleting reference guide. Manhattan: Kansas State University; 1994. p. 44-54.
[4] Lim C, Cuzon G. A review: Water stability of shrimp pellet. Asian Fisheries Science 1994;7:115-127.
[5] ASAE Standards. S269.4: Cubes, pellets, and crumbles – definitions and methods for determining density, durability and moisture content. St. Joseph, MI: ASABE; 2003.
[6] Fairchild F, Greer, D. Pelleting with precise mixer moisture control. Feed International 1999;20:32-36.
[7] Fahrenholz AC. Evaluating factors affecting pellet durability and energy consumption in a pilot feed mill and comparing methods for evaluating pellet durability [dissertation]. Manhattan: Kansas State University; 2012.
[8] Boonyaratpalin M. Water stability of prawn diets with different binders. Thai Fish Gaz 1981;34:661-667.