EFFECT OF BINDER PROCESSING ON FEED QUALITY

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ABSTRACT

This study was carried out to investigate the effect of binder processing on the quality of feed, viz; pelletabilty, hardness, friability and water stability. Four different starch sources were investigated; yam starch, corn starch, rice starch and cassava starch. Each starch was formulated into two diets employing two processing methods; cooked and un-cooked. The statistical analysis of the physical parameters of the diets indicated significant differences ($P < 0.05$) between different binders. Yam starch, rice starch, and cassava starch performed best in un-cooked form, while Corn starch exhibited best water stability in cooked form. The outcome of the research establishes the need for an appropriate method of binder processing which will assist fish farmers in the production of water stable pellets.

Key words: Binders, processing, water stability.

INTRODUCTION

Feed constitute about 60 % of the cost of production (Sá *et al*. 2006; Fu, 2005). On-farm aqua feed unlike livestock feed requires adequate level of processing to guarantee optimum availability to and utilization of compounded feed by the target fish (Wood, 1993). The role of binder in aqua feed is significant but the high cost of conventional synthetic binders make pellet feed production at on- farm level a difficult exercise especially for small and medium scale aquaculturists thus, most farmers resort to arbitrary inclusion of any available unconventional binding agent in the production of pelleted feed at any level of inclusion (Orire *et al*., 2005). This study seeks to establish appropriate processing methods of yam starch, corn starch, cassava starch, and rice starch that will produce good water stable pellets for on-farm fish feed manufacturers.

MATERIALS AND METHODS

Starch preparation

Four (4) different starches were prepared individually as follows:

Yam starch: Five (5) kilograms (kg) of white yam of the variety (*Discorea rotundata*) was peeled, washed and cut into smaller pieces. These pieces were ground into paste. Five litres of tap water was added to this paste and stirred thoroughly. The mixture was squeezed out using a muslin cloth 0.1 mm mesh size. The filtrate was allowed to settle overnight and the sediment from the filtrate was collected by pouring the liquid out from the container. The starch was collected and sun dried. 100 g was measured out with the aid of Metler Sensitive balance and divided into two portions which were then properly stored in refrigerator at 20^{0}C

Corn starch: Five (5) kilograms (kg) of dried maize (*Zea mays)* was soaked in water, washed and ground into paste. The paste was then squeezed out using a muslin- cloth and the filtrate was allowed to settle overnight. The starch sediment from the filtrate was collected and dried in the sun. The dried starch was then packaged in 100 g and divided into two portions and stored in a refrigerator at 20^0C.

Cassava starch: Four (4) kilograms (kg) of cassava (*Manihot esculenta)* was peeled, washed and divided into smaller pieces. These pieces were ground into paste. Four liters of tap water was added to the paste and stirred thoroughly. The mixture was squeezed out using a muslin cloth with 0.1 mm mesh size and the filtrate was allowed to settle over night. The liquid was gently poured out from the container and the starch sediment was collected and sun-dried. 100 g was measured and divided into two portions, packaged and stored in a refrigerator at 20^0C

Rice starch: Five (5) kilograms (5kg) of rice (*Oryza sativa)* was soaked in water, washed and ground into paste. The paste was then squeezed out using muslin – cloth and the filtrate was allowed to settle overnight. The starch sediment from the filtrate was collected and sun dried. The starch was then stored in a refrigerator at 20^0C.

Diet formulation, preparation and pelleting.

Eight (8) different diets were formulated at 35% crude protein (CP) using the Pearson square method. The diets were then compounded using two processing methods for the binders (cooked and un-cooked forms) The feed ingredients used were fish meal, soy bean meal and maize meal. The binders used were cassava starch, corn starch, rice starch and yam starch at recommended levels of inclusion; Yam starch at 5% (Orire, 1999), Corn starch at 10% (Orire *et al*., 2005), Rice at 13.3% (Wood, 1993) and Cassava at 20% (Orire *et al*., 2001). The pelleted diets were oven-dried at 60^0C. This was then stored in a refrigerator at 20^0C.

PHYSICAL PARAMETERS MEASURED

Physical parameters measured were; pelletability, hardness, friability and water stability.

Pelletability: The pelleted diet was sifted to separate the well formed pellets from the unformed. The percentage pelletability was obtained by expressing the weight of well-formed pellets to the total weight.

$$\text{Pelletability} = \frac{\text{weight of well-formed pellets}}{\text{Total weight of pellets}} \text{X100}$$

Hardness: An improvised pentagon nut was used to determine the degree of pellet hardness. Sample pellet of 5mm length was placed longitudinally between two rods and gently gripped. The pentagon nut was then turned slowly. The number of turns made until the pellet breaks was counted. This was repeated for 24 more pellets and the average numbers of turns were taken.

Water stability: 50g of feed sample was placed in a beaker into which 200ml of tap water was added. The container was subjected to occasional gentle shaking for 20 seconds every 2 minutes for the period of 20 minutes. The content was then made to pass over 2mm sieve and the material retained was sun-dried. Water stability was calculated thus:

$$= \frac{\text{weight after soaking}}{\text{Weight before soaking}} \times 100$$

Friability : 50g of pellet sample was put in a container and adapted onto a rotary machine at a constant speed level of 500 revolution per second at time intervals; 5, 10, 15 and 20 seconds. The dust produced was then taken using 2mm sieve and measured against the original weight as a percentage.

RESULT AND DISCUSSION

In Table 1, Yam starch indicated significant difference (P<0.05) in hardness for the two diets with respect to different processing methods applied to each one. The degree of hardness was higher in the diet with cooked starch and lower in the diet with un-cooked starch. There was also significant difference (P<0.05) in water stability between the diets (Table 1). Diet with uncooked starch was found to be more stable in water than the diet with cooked starch. There was significant difference (P<0.05) in friability between the diets with higher value in the diet with un-cooked starch and lower value in the diet with cooked starch (figure 1). The percentage pelletability was also found to have significant difference (P<0.05) between the diets. there was high degree of pelletability in diet with un-cooked starch and low degree of pelletability in diet with cooked starch.

The corn starch also exhibited no significant difference (P>0.05) with respect to hardness. Both the diets showed the same level of hardness as measured by pentagon nut. There was significant difference (P<0.05) in water stability between the diets. Diet with un-cooked starch was found to be more stable in water than diet with cooked starch. Friability of the diets was also observed to have significant difference (P<0.05) high degree of friability in diet with cooked starch while un-cooked starch was observed to have low degree of friability (figure 1). The percentage pelletability of the diet was also found to have high pelletability percentage compare with the uncooked starch (Table 1).

The rice starch showed significant difference (P<0.05) in the degree of hardness between the diets (Table 1). Diet with cooked starch was found to have higher degree of hardness compared with un-cooked diet. Water stability was also found to have significant (P<0.05) between the diets. diet with un-cooked starch was more stable in water while the diet with cooked starch was less stable in water. With respect to friability, there was also significant difference (P<0.05) between the diets. diet with un-cooked starch was found to have higher degree of friability while diet with cooked starch was found to have lower degree of friability (figure 1). Pelletability was also found to have significant difference (P<0.05) between the diets. diet with un-cooked starch was found to have higher percentage pelletability while diet with cooked starch was found to have lower percentage pelletability.

Table 1: **Physical Parameters of Different Starch Based Diet.**

...meters	Diet I	Diet II	Diet III	Diet IV	Diet V	Diet VI	Diet VII	Diet VI
...ness	2.10^{d} ±0.14	3.10^{cd} ±0.14	3.70^{c} ±.0.00	3.80^{c} ±0.28	4.00^{c} ±0.00	4.60^{bc} ±0.71	5.00^{b} ±0.71	6.20^{a} ±0.14
...ter ...ility	2.95^{b} ±0.49	1.80^{bc} ±0.14	5.30^{a} ±0.14	2.90^{b} ±0.14	1.50^{bc} ±0.00	0.50^{c} ±0.14	5.50^{a} ±0.28	2.00.^{bc} ±1.1.1
...bility	5.00^{b} ±0.28	3.80^{d} ±0.42	5.60^{bc} ±0.00	7.00^{a} ±0.00	7.40^{a} ±0.14	6.00^{c} ±0.42	7.00^{a} ±0.14	6.00^{c} ±0.14
...lletability	3.20^{d} ±0.28	2.60^{d} ±0.28	5.60^{b} ±0.00	6.00^{b} ±0.00	7.00^{a} ±0.14	4.00^{c} ±0.42	7.30^{a} ±0.14	6.00^{b} ±0.42

Means on the same row carrying different letters differ significantly from each other ($p < 0.05$)

DIET I= Yam Starch un-cooked

DIET II= Yam Starch cooked

DIET III= Corn Starch un-cooked

DIET VII= Cassava Starch un-cooked

DEIT IV = Corn Starch cooked

DIET V= Rice Starch un-cooked

DIET VI= Rice Starch cooked

DIET VIII= Cassava Starch cooked

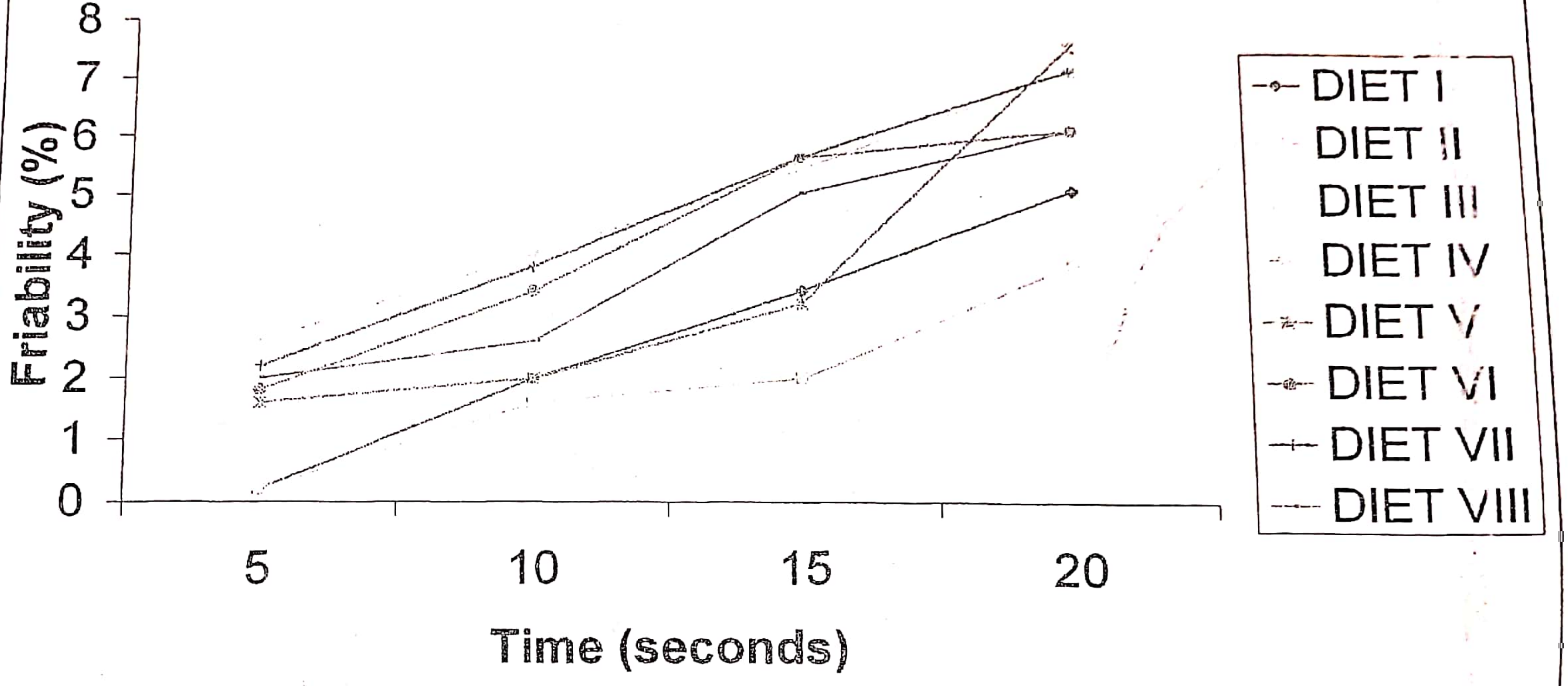

Fig.1: Friability of eight diets over a period of twenty seconds

From the results above, it was observed that fish feed stability in terms of formation with respect to their physical parameters; hardness, water stability, friability and pelletability expresses high degree of variability regarding different processing methods applied to each diet. It was observed that yam starch exhibited high degree of hardness when the pellet was made with a cooked starch. Moreover, this would be assumed to be the best diet but its water stability is very low. High degree of water stability was exhibited by yam starch in its un-cooked form but with low level of hardness. Furthermore, high degree of pellets friability and pelletability were observed in un- cooked forms. This can be attributed to high gumming of pellets due to gelatinization of the starch. The gumming together of starch is a function of adhesive property of the binder (Dominy *et al.*, 1991; Dominy and Lim, 1991; Stivers, 1970). Thus, for yam starch, good pelletability, hardness and friability, can be achieved at un-cooked form. It can be concluded that yam starch at un-cooked form produces pellets which exhibited good water stability and this makes it suitable for feeding aquatic animal since this ensures pellets that will not disintegrate in water in a very short period of time (De Silva and Anderson,1995). On the other hand, yam starch in a cooked form produces pellets with high degree of hardness which makes it appropriate form that ensures pellet that are durable to handling and transportation (De silva and Anderson, 1995).

On corn starch, high degree of water stability was exhibited at un-cooked form. This appears to be the best diet but it expresses low degree of friability. Corn starch in cooked form exhibited high degree of friability and water stability. High degree of water stability exhibited by corn starch in a cooked form may be due to the cooking effect on the starch which enhances gelatinization (Stivers 1970). The author stated that some processing parameters have effects on stability of pellets. Corn starch exhibited the same degree of hardness both in cooked and un-cooked forms. Thus corn starch in its cooked form yielded diets with high water stability and pelletability and this makes it to be an appropriate method to produce best and water stable pellets. This compared favorably with the report of Jauncey (1992) which revealed that pellets with high percent pelletability are best water stable.

Rice starch was observed to show excellent feature as high water stable in it un-cooked form, however the level of hardness is low. On the other hand, high degree of pelletability was exhibited by rice starch in a cooked form. The friability was also found to be high in cooked form. Thus, for rice starch, best water stable pellets can be achieved by cooking method and this makes it be an appropriate method for producing high stable pellet that will remain intact until it is consumed for at least 20 minutes before leaching or disintegration in the aquatic medium (Pigott *et al*, 1989).

Cassava starch was observed to exhibit high degree of hardness in cooked form but shows low degree of water stability. High degree of hardness in cooked form may be as a result of cooking effects on the starch as reported by Stivers (1970) that some processing parameter have effect on the quality of feed. On the other hand, cassava starch in its un-cooked form shows high degree of water starch ability, friability and pelletability. Thus, for cassava starch, high water stable, friability and pelletability can be achieved only by using un-cooked method and this makes it an appropriate method for producing pellets with can maintain their physical structures in water before they are consumed by the targeted fish (Orire *et al.*, 2001; De silva and

Anderson. 1995). The processing methods examined in this study will go along way to reduce aquatic pollution by poor water stable diets as a result of leaching from (Somsveb, 1993). It will also reduce problem of un-available and expensive synthetic binders which might even be toxic and contain anti- binder factors (Asiedu, 1992).

CONCLUSION AND RECOMMENDATION

The finding was a significant indicator pointing to the need for appropriate processing method for binders in diet preparation to ensure good pelleted feed that gives optimum utility by the aquatic organisms with minimal leaching of nutrients and water pollution which are appropriate for sustainable aquaculture production.

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