Journal of Aquaculture Research & Development

Orire and Emine, J Aquac Res Development 2019, 10:2
DOI: 10.4172/2155-9546.1000565

Research Article Open Access

Effects of Crude Protein Levels and Binders on Feed Buoyancy

Orire AM* and Emine GI

Faculty of Aquaculture and Fisheries Technology, Department of Water Resources, Federal University of Technology, Minna, Nigeria

Abstract

The research determined the effects of crude protein levels and selected natural binders (Cassava, Corn, Rice and Yam) on feed floatability. Eight (8) diets each were prepared at 30%, 35%, 40%, 45% crude protein level. Four parts each of the diets were incorporated with raw and gelatinized binders at appropriate inclusion levels. The results obtained were significantly different ($p<0.05$) for inclusion levels of crude protein and pellets floatability. Cassava binder gave the best floatability percentage of 100% for all crude protein levels which floated for 60 minutes while the raw binder incorporated pellets performed poorly except for yam binder that gave 70% floatation rate at 40% crude protein levels. Thus, while considering the right polysacharides as binder for on-farm floating feed, Cassava binder is recommended.

Keywords: Floating; Feed; Fish; Crude protein levels

Introduction

The overall goal of aquaculture is to enhance sustainable development of fisheries resources thereby making the world self-sufficient in fish production. Fish is an excellent source of dietary proteins, vitamins, fats and minerals that are essential in human diet, it is also responsible for about 55% of protein intake sources of Nigerian citizens however, fish is under supplied with a demand gap of 1.0 million metric tons [1]. The production of fish feed is a relevant factor to be considered in both commercial and small-scale fish [2]. Fish feeds unlike livestock feeds face major threats to its stability before reaching the target in aquatic medium [3-5]. Carbohydrates are good sources of energy and as well good feed binders [6]. Numerous natural binders have been employed to produce firm pellets with the purpose of increasing their stability in water and to reduce nutrient loss. Polysaccharides such as starch, cellulose etc are non-toxic and available in abundance and are gaining importance as promising biopolymers to be employed as binders [7] few examples of these binders are corn, starch, rice starch, yam starch, Cassava starch and so on. Binders have a significant role in aquaculture feed production but due to high cost of conventional synthetic binders, pelleted feed production at on-farm level becomes difficult mostly for peasant and medium scale farmers. This makes farmers to resort to arbitrary inclusion of any available unconventional binding agents for feed production at any inclusion level [8]. The achievement of a stable pellet in the aquatic medium guarantees almost whole some delivery and optimum utilization of nutrients by the fish [9] unlike the granulated feed whose nutrients would almost be lost in water before reaching the target fish. Fish feeds require adequate level of processing to ensure optimum availability and utilization of compounded feed by the target fish unlike livestock feeds fish feed needs to be firm to handle and maintain a reasonable degree of stability in the aquatic medium long enough for fish to consume it [3,4,5,10]. Floating feeds are said to be hydrophobic with low rate of leaching ccompared to conventional sinking feed [11]. The use of natural binding agents for enhancing on-farm floating feed may replace the expensive expanded floating feeds produced by extrusion [12,13]. Pellets that easily dissolves in water would fastly leach their nutrients into the water thereby reducing the quality of the culture environment and subsequently leading to poor growth of fish, inefficient feed conversion and low survival rate. [14]. Therefore, feeds need to be highly stable in water to prevent increment in feed cost and provide greatest proportion of available nutrients to the culture animal [5]. The uneaten feeds that sinks to the bottoms of the pond may end up as fertilizer thereby causing high algal bloom and other water pollution problems especially in areas where there is scarcity of water [15,16] but due to the low cost and technology of producing sinking feed it is the choice of most fish farmers especially in developing countries like Nigeria. This research, therefore, investigated the effects of crude protein levels and natural binders on floating feed performance.

Materials and Methods

The materials used in carrying out this experiment are fish meal, wheat flour, baker's yeast, vegetable oil, binders, (rice, yam, corn and Cassava), vitamin, mineral premix, plastic spoon, bowls, warm water (40°C), sensitive weighing scale (M300) and a hand pelleting machine. The research was carried out in the laboratory of Water Resources, Aquaculture and Fisheries Technology Department of the Federal University of Technology Minna, Niger State, Gidan Kwanu Campus.

Source of feed stuffs

The ingredients used for the experiment are wheat flour, vegetable oil, bowls and Baker's yeast purchased from the Kure's Ultra-modern market in Minna, Niger State. Fish meal, mineral premix was procured from a Fish meal store in Minna. The starches from yam, corn, Cassava were processed according to Orire et al. [8] while the rice starch was done according to the method of Suleiman et al., [17] as follows:

Processing of yam starch: Two kilogrammes (2 kg) standard size tuber of yam of variety *Discorea rotundata* (white yam) was peeled, washed and grated. The paste of 4 litres was then mixed with sufficient quantity of water to allow for exudation of the starch from the fibre. The solute was then poured into a cheese cloth and squeezed to obtain the starch solution filtrate. This was then allowed to stand overnight for proper separation. The supernatant was decanted to obtain the starch which was sun dried at about 36°C for 8 hours and packaged for storage in a deep freezer (-4°C) for later use.

***Corresponding author:** Orire AM, Faculty of Aquaculture and Fisheries Technology, Department of Water Resources, Federal University of Technology, Minna, Nigeria, Tel: +234 906 174 8691; E-mail: abdul.orire@futminna.edu.ng

Received December 18, 2019; **Accepted** March 13, 2019; **Published** March 20, 2019

Citation: Orire AM, Emine GI (2019) Effects of Crude Protein Levels and Binders on Feed Buoyancy. J Aquac Res Development 10: 565. doi: 10.4172/2155-9546.1000565

Processing of Cassava starch: One tuber of Cassava (*Manihot esculanta)* was peeled, washed and grated. It was the squeezed and sieved through a cheese-cloth to obtain the starch soluble filtrate: this was left to stand overnight after which the supernatant was decanted to obtain the starch. This was sun dried for 6 hours and packed.

Processing of maize starch (*Zea mays*): Dried maize of five kilogrammes (5 kg) was soaked in water, washed and ground into paste. The paste was squeezed out with a Muslin Cloth and the filtrate was allowed to settle overnight. The starch sediment from the filtrate was collected and dried in the sun at about 36°C for about 6 hours, and then the dried starch was then packed for incorporation in the diets.

Processing of rice starch: Five (5) kilograms (5 kg) of rice (*Oryza sativa*) was soaked in water, washed and grounded into the paste. The paste was then squeezed and 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 deep freezer (-4°C) for later use.

Diets preparation

Pearson Square method of feed formulation was used to formulate eight diets different crude proteins; 30%, 35%, 40% and 45% compounded by addition of proportion part of other feedstuffs with inclusion of raw and gelatized binders according at recommended inclusion levels; corn starch (15%) [8], Cassava starch (20%) [18], rice starch (15%) [17] and yam starch (20%) [19] and Baker's yeast at 5% [20] for all the feed (Table 1). Warm water (40°C) was added to produce a semi-solid dough. The dough was incubated for 30 minutes and then pelleted using hand pelleting machine, sundried and kept in the deep freezer (-4°C) for further analysis.

Feed buoyancy test

The floating ability of pellets using yam, Cassava, corn and rice binders with 5% floating agents (Baker's yeast) were evaluated for 1 hour. 10 pellets were randomly selected, put in a 250 ml beaker with 150 ml of fresh water. With the aid of a stop watch, degree of floatation was recorded within the time frame of 1 hour [21] [Tables 2-6].

Figure 1 shows the floatability performance of 30% crude protein pellets incorporated with varying raw binders. The Cassava binder had 100% floatation for the first 10 minutes then dropped to 90% for 25 minutes, 80% for 35 minutes but maintained 70% for the remaining period of 60 minutes. The corn binder gave 90% floatability for the first 15 minutes, then fell to 80% for 25 minutes, 70% for 40minutes and 40% to the end of the test. The rice binder pellets had similar trend with Cassava starch-based diets up till 45 minutes but dropped to 55% for the rest of time while the yam binder pellets exhibited the lowest floatation rate of 80% for the first 10 minutes which then fell to 50% in 25 minutes and 30% for the rest of the period.

Figure 2 shows the floatability response of 30% crude protein incorporated gelatinized varying binders pellets. Cassava binder pellets gave 100% floatation for 60 minutes while rice binder also gave 100% but for 40 minutes which then dropped to 80% throughout the floatation period. The corn binder-based pellets had 100% floatation for the first 10 minutes, then dropped to 80% for 40 minutes and 50% for the rest of the period. The yam starch binder pellets had 80% floatation rate for the first 10 minutes, 70% for 20 minutes and 50% for the rest of the period.

Feed stuffs (%)	Crude protein	Moisture	Ash	Lipid
Fish meal	65.28	4.82	10.70	16.68
Wheat flour	13.13	7.82	0.45	3.99

Table 1: Proximate analysis of feed stuffs.

Floatability rate of 35% crude protein with raw starch incorporated binders was evaluated for 60 minutes with significant difference ($p<0.05$) in buoyancy. Corn binder pellets gave 100% floatation for the first 15 minutes with gradual sinking to 10% by the 55 minutes. The Cassava binder pellets had a low floatation rate of 90% for the first 15 minutes which also dropped steadily to 30% by the 35th minutes of the

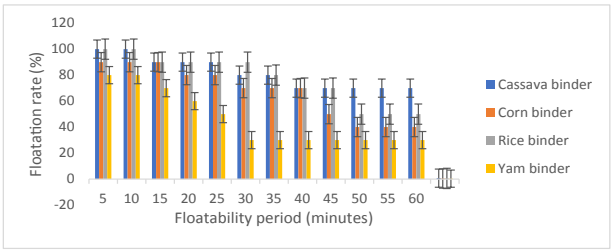

Figure 1: Pellets buoyancy for 30% crude protein incorporated with varying raw binders.

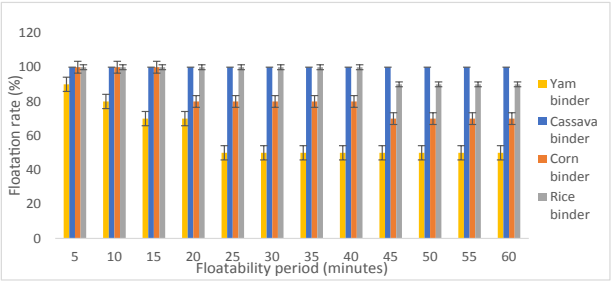

Figure 2: Pellets floatation rate for 30% crude protein incorporated with gelatinized binders.

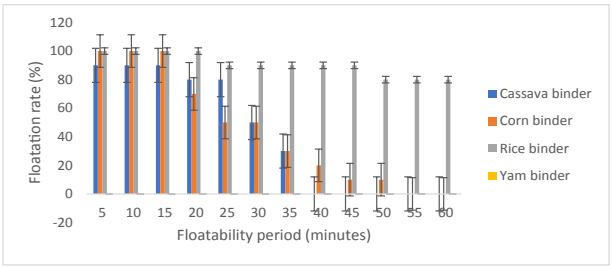

Figure 3: Pellets buoyancy for 35% crude protein incorporated with varying raw binders

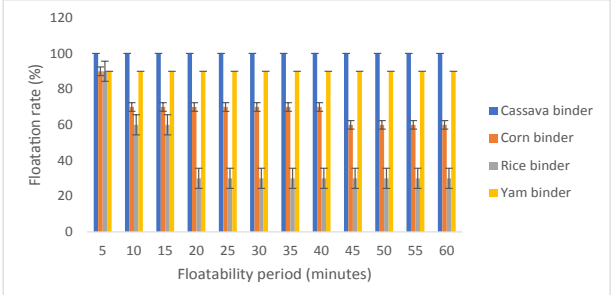

Figure 4: Pellets floatability rate for 35% crude protein incorporated with varying gelatinized binders.

test. However, rice binder pellets exhibited 100% floatation for the first 20 minutes, 90% for 45 minutes and 80% for the rest of the period. Moreover, the yam starch-based diet had 0% floatation (Figure 3).

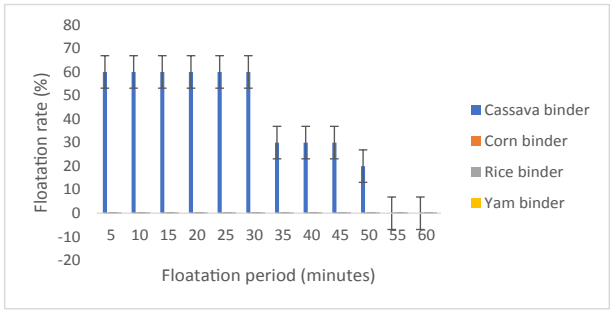

Figure 5: Pellets floatability rate for 40% crude protein incorporated raw binders.

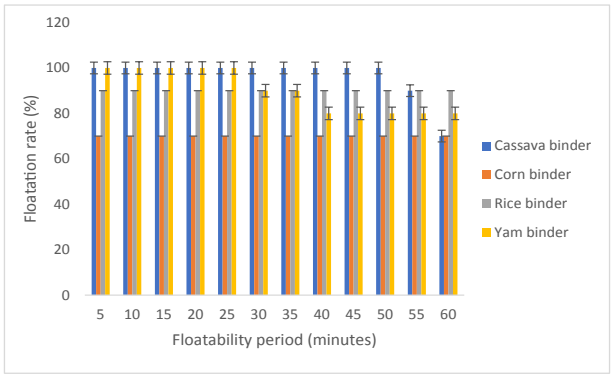

Figure 6: Pellets buoyancy test for 40% crude protein incorporated varying gelatinized binders.

The percentage floatability of 35% crude protein with incorporated gelatinized binder pellets is presented in Figure 4. Cassava binder pellets had 100% floatability for 60 minutes buoyancy period followed by yam binder pellets with 90% floatation rate also floated for 60 minutes. However, corn binder had an average buoyancy rate of 60% while rice binder pellets had low 30% floatability for 60 minutes.

Figure 5 shows the floatability rate of 40% crude protein pellets incorporated raw binders. Cassava binder had 60% floatability for 30 minutes which dropped to 30% and 20% for 45 and 50 minutes respectively while other binders had 0% floatation.

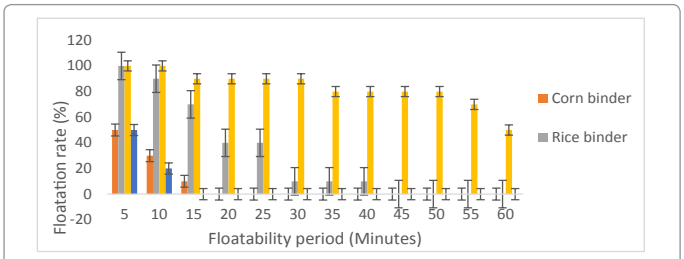

Figure 7: Pellets buoyancy test 45% crude protein incorporation varying raw binders.

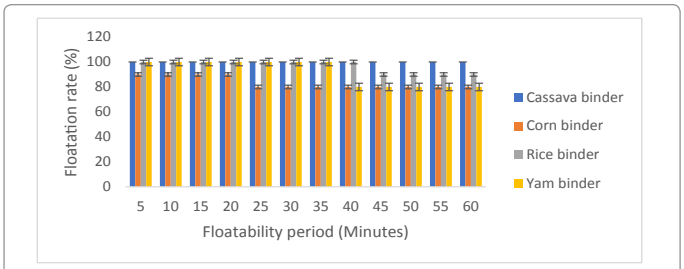

Figure 8: Pellets floatability test for 45% crude protein incorporated with varying gelatinized binders.

Feed stuffs (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	Diet 8	Diet 9
Wheat flour	57.50	47.30	43.90	43.90	47.30	43.30	43.90	47.30	43.90
Fish Meal	27.70	27.60	21.00	21.00	22.60	22.60	21.00	22.60	21.00
Mineral premix	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Lipid	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Baker's yeast	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Yam starch	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	20.00
Cassava starch	0.00	0.00	20.00	0.00	0.00	0.00	20.00	0.00	0.00
Rice starch	0.00	15.00	0.00	0.00	0.00	0.00	0.00	15.00	0.00
Corn starch	0.00	0.00	0.00	0.00	15.00	15.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Key: Diet 1 (Control); diets 2-5 (Raw binder pellets); diets 6-9 (Gelatinized binder pellets).									

Table 2: Feed formulation for 30% crude protein level with varying binders.

Feed stuff (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	Diet 8
Wheat flour	27.20	27.20	29.30	29.30	27.20	27.20	29.30	29.30
Fish Meal	37.80	37.80	40.70	40.70	37.80	37.80	40.70	40.70
Mineral premix	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Lipid	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Baker's yeast	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Yam starch	20.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00
Cassava starch	0.00	20.00	0.00	0.00	0.00	20.00	0.00	0.00
Rice starch	0.00	0.00	15.00	0.00	0.00	0.00	15.00	0.00
Corn starch	0.00	0.00	0.00	15.00	0.00	0.00	0.00	15.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Key: Diets 1-4 (Raw binder pellets); diets 4-8 (Gelatinized binder pellets)								

Table 3: Feed formulation 35% crude protein diets with varying binders.

Feedstuff (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	Diet 8
Wheat flour	33.40	33.40	36.00	36.00	33.40	33.40	36.00	36.00
Fish Meal	31.60	31.60	34.00	34.00	31.60	31.60	34.00	34.00
Mineral premix	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Lipid	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Baker's yeast	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Yam starch	20.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00
Cassava starch	0.00	20.00	0.00	0.00	0.00	20.00	0.00	0.00
Rice starch	0.00	0.00	15.00	0.00	0.00	0.00	15.00	0.00
Corn starch	0.00	0.00	0.00	15.00	0.00	0.00	0.00	15.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Key: Diets 1-4 (Raw binder pellets); diets 4-8 (Gelatinized binder pellets)								

Table 4: Feed formulation 40% crude protein diets with varying binders.

Feedstuff (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	Diet 8
Wheat flour	29.02	29.02	29.02	31.25	29.02	29.02	29.02	31.25
Fish Meal	35.98	35.98	35.98	38.75	35.98	35.98	35.98	38.75
Mineral premix	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Lipid	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Baker's yeast	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Yam starch	20.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00
Cassava starch	0.00	20.00	0.00	0.00	0.00	20.00	0.00	0.00
Rice starch	0.00	0.00	15.00	0.00	0.00	0.00	15.00	0.00
Corn starch	0.00	0.00	0.00	15.00	0.00	0.00	0.00	15.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Key: Diets 1-4 (Raw binder pellets); diets 4-8 (Gelatinized binder pellets)								

Table 5: Feed formulation 42% crude protein diets with varying binders.

Feed stuff (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	Diet 8
Wheat flour	39.72	39.82	42.78	42.78	39.72	39.82	42.78	42.78
Fish Meal	25.28	25.28	27.22	27.22	25.28	25.28	27.22	27.22
Mineral premix	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Lipid	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Baker's yeast	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Yam starch	20.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00
Cassava starch	0.00	20.00	0.00	0.00	0.00	20.00	0.00	0.00
Rice starch	0.00	0.00	15.00	0.00	0.00	0.00	15.00	0.00
Corn starch	0.00	0.00	0.00	15.00	0.00	0.00	0.00	15.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Key: Diets 1-4 (Raw binder pellets); diets 4-8 (Gelatinized binder pellets)								

Table 6: Feed formulation 45% crude protein diets with varying binders.

Floatability performance for 40% crude protein pellets incorporated gelatinized binders is shown in Figure 6. Cassava binder pellets had 100% floatability for 50 minutes and 80% for the rest of the period. The yam binder-based pellets also had 100% floatation for 25 minutes then fell to 90% by the 55th minutes. However, rice and corn binders-based pellets had 90% and 70% floatation rate for 60 minutes respectively.

Figure 7 shows floatability performance of pellets at 45% crude protein incorporated with varying raw binders. The result shows significant difference ($p<0.05$). Cassava binder had 100% for 50 minutes and 90% for the rest Yam binders' pellets had 70% for 55 minutes Cassava and rice binders pellets had 30% floatability for 10 and 25 minutes respectively while corn binder pellet had 10% floatation for 10 minutes.

Figure 8 shows the floatability performance of pellets that contains 45% crude protein incorporated different gelatinized binders with significant difference ($p<0.05$) for 60minutes buoyancy test. Cassava binder pellet had 100% floatability for 60 minutes, followed by rice-based binder pellets with 90%, yam and corn binder pellets 80% all of which floated for 60 minutes.

Discussion

The results of the experiment show that binders, its form and crude protein levels had effects on the pellets buoyancy for all diets tested. The Cassava binder-based pellets showed high buoyancy with gelatinized binder in agreement with the report of Adeparusi and Famurewa [22] than raw binder-based pellets which could be attributed to low gumming and polarity between starch and liquid [23]. Cassava binder pellets exhibited high buoyancy rate of 100% for 60 minutes at all levels of crude protein levels when incorporated with gelatinied binder. Other binders also performed very well but at a lesser floatability rate to Cassava binder. However, raw incorporated at 30% crude protein

level gave a reasonable buoyancy rate of 70% and above for Cassava, rice and corn and at 45% crude protein for yam binder. This finding is in agreement with the report of Adeparusi and Famurewa that better feed stability was achieved with gelatinized rice and wheat binders. Furthermore, low floatability rate recorded for pellets with raw binders could be attributed to low polarity between the polysacharide and the liquids [23] and low degree of gelatilization [24] which aided water percolation into the feed as observed with pellets with raw binders as against the gelatinized binder pellets in this finding. Generally, the presence of wheat flour in the feedstuff's constituents aided pellets stability and thus floatation as observed in this study and Ahmed et al., study [19,25]. The decline in pellets water stability that resulted in low floatability with increase in crude protein level could be attributed to low polysachrides in the feedstuffs which can implicate on the nutrient loss due to leaching [16].

Conclusion

Pellets with geletinized binder especially the Cassava binder produced high floating pellets than raw binder pellets. Similarly, the higher the crude protein level the lower the pellet floatabilty for other binders. Gelatinized Cassava starch is recommended as binder for production of on-farm floating feed in place of synthetic binders.

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