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REPLACEMENT OF WHEAT FLOUR WITH WHEAT BRAN FOR FLOATING FISH FEED PRODUCTION

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ABSTRACT

Wheat bran does not only serve as raw material for animal feeds; it has also become a natural additive due to its high mineral contents such as calcium, sodium, potassium, iron, phosphorus etc. wheat flour has been used as binder which help in enhancing fish feed buoyancy for decades, This research examined the viability of replacing wheat flour with wheat bran for on-farm floating feed production aimed at reducing cost and improving environmental sustainability. Five feeds with replacing level of wheat flour by wheat bran at 0%, 25%, 50%, 75% and 100% were formulated at 30% and 40% crude proteins using Pearson Square method. Inferential statistics analysis using line graphs revealed significant differences (p<0.05) among treatments' floatability rates. The results revealed that feed formulated at 30% crude protein floated for 55% at 75%WB/25%WF. This demonstrates the roles of starch at low crude protein level and also gluten in wheat flour that enhance the buoyancy of feed than a more fibrous feed of the wheat bran while 40% crude protein levels exhibited 40% floatation at 25%WB/75%WF. Low floatation rate recorded in this study could be attributed to high fibre content of the wheat bran, Both crude protein levels had 100% floatation at 100 wheat flour which floated for the whole 60 minutes period. It can be concluded that, wheat bran can replace wheat flour at 75% at 30% crude protein and 25% for 40% crude protein for producing floating fish feed beyond which feed buoyancy may not be achieved.

Keywords: wheat bran, wheat flour, extruded feed, buoyancy, pellets.

INTRODUCTIONAquaculture is the cultivation of aquatic plants and animals, such as fish, shellfish, and algae, in controlled environments like ponds, tanks and nets (FAO, 2020). Aquaculture plays a vital role in providing affordable high-quality protein all around the world for human consumption. Fish is a rich source of essential nutrients, and its consumption contributes to improved nutrition and health outcomes. The World Health Organization (WHO) emphasizes the nutritional benefits of fish consumption, particularly in addressing malnutrition and enhancing dietary diversity (WHO, 2021). About 40% of Nigerians' animal protein intake comes from fish (FAO, 2020). Essential nutrients include protein, vitamins (including B12 and D), minerals (such as iodine and selenium), and omega-3 fatty acids are abundant in fish. Eating enough fish improves nutrition and health outcomes, particularly for vulnerable groups like children and expectant mothers. Additionally, fish is easier to chew for younger and older people because it has less connective tissue than other meats like beef, pork and chicken (Kumar *et al*., 2013).

Fish species have specific nutritional needs and a balanced diet that fulfills their unique nutritional requirement to maximize growth (NRC, 2011). Feed takes a significant part of aquaculture costs and for financial sustainability of fish farming operations, feed conversion optimization and waste reduction are essential (Craig and Helfrich, 2009).

Extruded feed, also known as floating feed, plays a crucial role in modern aquaculture due to its effectiveness in promoting fish growth, reducing waste, and enhancing feed management (Sorensen, 2012). Unlike sinking feed, floating feed remains on the water's surface, allowing fish farmers to better monitor and control feeding behavior (Hardy, 2010). Floating feed reduces feed loss and environmental pollution by ensuring that most of the feed is consumed by the fish before it can sink and degrade (Yang *et al*., 2018; Naylor *et al*., 2000). Incorporating wheat bran and wheat flour in aqua feeds can influence the digestibility of the feed and promote growth in aquatic species (Nunes *et al*., 2013).

Majority of fish feed binders use in aqua feed are synthetic which are expensive, to help mini scale fish farmers there is need for alternatives available and affordable binder. Wheat bran is a low cost by-product of the milling process of wheat flour production available in abundance. The fiber and bioactive ingredients in wheat bran can improve the nutritional makeup of feed due to its high mineral contents (Bahar, 2020). The texture and mechanical strength of extruded meals are influenced by wheat bran. Though a higher bran concentration may reduce oxidative stress during rupture due to its diminished adhesion capabilities, it is also considered brown gold by some researchers and its enormous application and high market value make it very important (Bahar, 2020). Moreover, using ultra-fine bran grinding can enhance the qualities of the dough, which could result in better feed formulations (Jinli *et al*., 2012) and affordability than use of wheat flour.

Thus need to know the right inclusion replacement level.

MATERIALS AND METHODS

Materials

The materials used in carrying out this research are fishmeal, wheat flour, wheat bran, baker's yeast, sensitive weighing scale, warm water, plastic bowls, plastic spoon and hand pelleting machine.

Experimental site

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 Kwano Campus.

Sourcing for Feedstuffs

The ingredients such as, wheat flour, baker's yeast was purchase in Minna Metropolis, Kure market, Niger state. Fishmeal, mineral premix, bowls and spoon were purchased from a fishmeal store also in Minna.

Processing of Wheat Bran

During milling, the exterior layer of the wheat kernel known as wheat bran is removed. After the wheat grains have been cleansed to remove impurities, moisture is added during the conditioning step of the production process to facilitate separation. Grinding the wheat during the milling process separates the bran from the endosperm and other ingredients. Next, the bran is sifted and purified to ensure it is free of flour particles. The bran may occasionally be pelleted or given additional grinding to facilitate handling. This high-fiber by-product is often mixed with other components to give buoyancy and stability to balanced animal feed (Brouns, 2006; Jones and Engleson, 2010).

Proximate Analysis

Proximate analysis of feedstuffs was carried out for crude protein, moisture content, ash content and lipid in the Water Resources Aquaculture and Fisheries Technology laboratory as described by (AOAC, 2000).

Table 3: Proximate Analysis of Feedstuffs

Feedstuffs	% Crude Protein	% Moisture	% Ash	% Lipid
Fishmeal	59.06	5.99	8.88	16.15
Wheat flour	14.44	7.33	1.93	3.19
Yeast	40.69	3.33	2.10	0.60
Wheat bran	15.5	7.86	3.99	3.76

Feed Formulation

The person square method was used to formulate five diets containing 30% and 40% crude protein respectively. Wheat bran (WB) and wheat flour (WF) were replaced at various inclusion levels of 0%, 25%, 50%, 75% and 100%.

Table 1: Formulated feeds at 30% crude protein.

Feed Ingredients (%)	Feed 1	Feed 2	Feed 3	Feed 4	Feed 5
Fish meal	66.93	66.93	66.93	66.93	66.93
Wheat flour	28.07	7.02	14.04	21.06	0.00
Baker's yeast	5.00	5.00	5.00	5.00	5.00
Wheat bran	0.00	21.06	14.04	7.02	28.07
Total	100.00	100.00	100.00	100.00	100.00

Key: Feed 1 (100% /0%WB); Feed 2 (25%WF/75%WB); Feed 3 (50%WF/50%WB); Feed 4 (75%WF/25%WB); Feed 5 (0%WF/100%WB)

Table 2: Formulated Feeds at 40% Crude Protein.

Feed Ingredients (%)	Feed 1	Feed 2	Feed 3	Feed 4	Feed 5
Fish meal	45.57	45.57	45.57	45.57	45.57
Wheat flour	49.62	12.40	24.82	37.22	0.00
Baker's yeast	5.00	5.00	5.00	5.00	5.00
Wheat bran	0.00	37.22	24.82	12.40	49.62
Total	100.00	100.00	100.00	100.00	100.00

Key: Feed 1 (100% /0%WB); Feed 2 (25%WF/75%WB); Feed 3 (50%WF/50%WB); Feed 4 (75%WF/25%WB); Feed 5 (0%WF/100%WB)

Feed Preparation
Each feed ingredient was measured according to formulation and mixed together in a dried plastic bowl to attain homogeneity. Warm water (40°C) was added and well mixed to create a homogenous dough, pelleted and sundried for 24 hours at 60°C according to the method of (Adekunle *et al*., 2012).

Feed Buoyancy Test
A 250 ml beaker partly filled with water was used to assess the buoyancy of each feed by dropping 5 pellets into the water. A digital timer was used to record the degree of floatation for 60 minutes duration (Adekunle *et al*., 2012).

RESULTS

Floatability of On-farm Feed Formulated at 30% and 40% Crude Protein with Replacement of wheat flour (WB) with wheat bran (WB).

30% Crude Protein Floating Feed
At 30% crude protein, 100% WF showed 100% flotation rate for 60 minutes than other treatments. However, 75% WB/25% WF fell to 40% floatation which floated for 55 minutes while 50%WB/50%, WF 75%WB/25% and 100WBF has very poor floatability, feed started to sink immediately. This suggests that feed floatability at this protein level is maintained by a high inclusion level of wheat bran (figure 1).

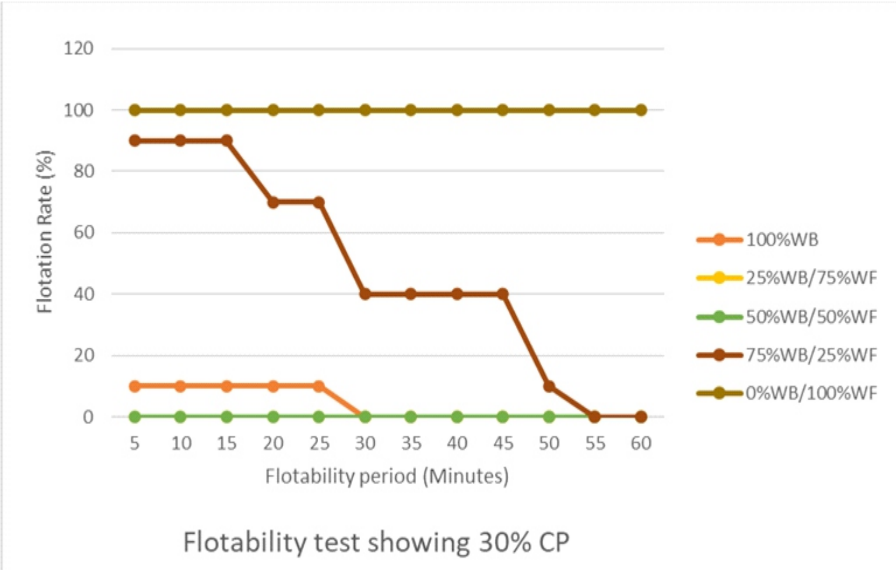

Figure 1: Floatability test showing at 30% Crude Protein

40% Crude Protein Floating Feed
At 40% crude protein level, feed buoyancy graph indicated that all treatments did poorly except for 100 wheat flour-based feed. The 50% WB/50 WF and 75%WB/25%WF gave a poorer flotation rates than 25%WB/75%WF which floated at 40% for 40 minutes (figure 2).

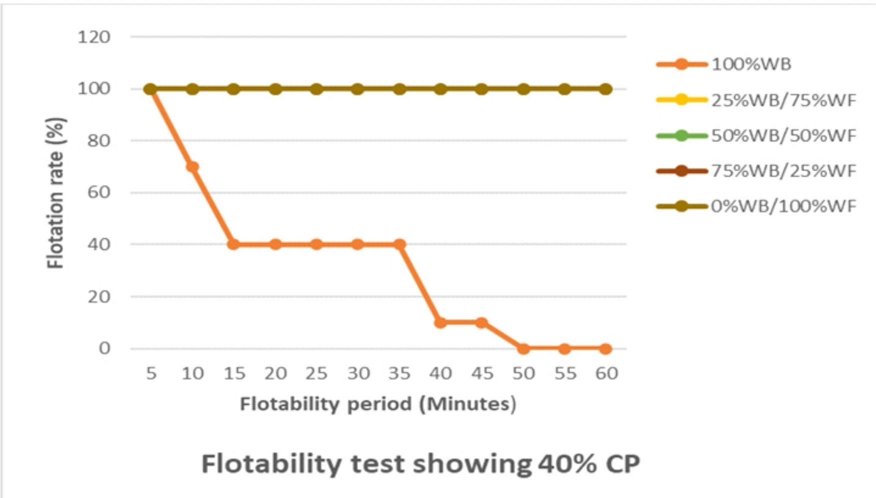

Figure 2: Floatability test showing 40% Crude Protein

DISCUSSION

From the findings, all formulated feeds at both 30% and 40% crude protein levels exhibited poor floatability performance except for 75%WB/25%WF at 30% crude protein level and 25%WB/75%WF at 40% crude protein. This demonstrates the roles of starch at low crude protein level and also gluten in wheat flour that enhance the buoyancy of feed than a more fibrous feed of the wheat bran (Nuens, 2013).

In contrast, diets containing 40% crude protein for fish species with higher protein requirements, such as fingerlings and carnivorous species. The high protein level reduces the starch component of the feed which invariably affects the adhesiveness and buoyancy of feed (Orire and Zaynab, 2020). When paired with sufficient starch levels, a higher protein content can influence the density of the feed and result in a balanced, floating meal that satisfies the fish's nutritional needs and offers the best possible flotation (Orire *et al*., 2020).

Consequently, the use of wheat bran must be managed with other additions to avoid reduction in flotation. Practical feed formulations can benefit from the addition of wheat bran as a cost-saving measure, and judicious use of wheat flour ensures that the feed retains its intended floating features. Low floatation rate recorded in this study could be attributed to high fibre content of the wheat bran (Robin *et al.*, 2011). Ingredients that are high in starch, like wheat flour could enhance the floatability and other physical characteristics of pellets. Moreover, improving particle size of the wheat bran to ultra-fine level could equally improve on its adhesiveness for high feed buoyancy (Jinli *et al*., 2012).

CONCLUSION

The observation of the floating performance of feed at different protein level shows that wheat bran can replace wheat flour up to 75% at 30% crude protein and 25% at 40% crude protein feed. Therefore, to increase the replacement level, improvement needs to be made on the particle size of the wheat bran to break down the fibre content.

Recommendations

Fish farmers can substitute wheat flour with wheat bran up to 75% at 30% crude protein level and 25% at 40% crude protein level beyond which poor floatability is recorded.

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