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Suitability of cassava (*Manihot esculenta*) starch as feed binder

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ABSTRACT

This study investigated the effect of cassava starch as binder on feed quality and the appropraite level of its inclusion in feed processing for desirable pellet. Five levels of starch inclusion, viz; 0, 5, 10, 15 and 20% were investigated. The binding propensity of cassava starch was evaluated by its pelletability, hardness, dust, water stability and friability. Variation in levels of starch inclusion on binding property was found to be significant ($p<0.05$). The 5% starch inclusion level was the worst due to under-binding and consequently poor pelletability while binding was at its best at starch level of 20%. This binding is of immense importance to aquaculture feed industry and more importantly farm-made aquafeed production. Promotion of starch sourcing from locally available natural carbohydrates will provide affordable alternatives to conventional binders. Establishing the appropriate level of inclusion will undoubtedly reduce feedstuff and binder wastage during feed production and enhance feed availability to fish.

INTRODUCTION

A great potential abound in the tropics for the establishment of starch manufacturing industry in view of the high agricultural, industrial and domestic demand for starch, coupled with the super-abundance of natural agricultural starch sources. In some tropical countries like Nigeria, the world largest producer of cassava, and Brazil, a leading producer of cassava, establishment of cassava-based agro-allied industry will be beneficial with a potential to export processed cassava, its products and by-products including cassava starch.

There is high demand for binder in the feed industry. Conventional binders are synthetic and often imported into most tropical countries. There is obviously the problem of availability and affordability of such imports. In addition, majority of animal farms including fish farms, are owned by small scale stakeholders who rely mostly on locally available feedstuffs (on-farm) for feed production, hence the need for local sourcing of feedstuffs.

Farm-made aqua-feed unlike livestock feeds need adequate processing (compounding) to ensure optimum availability to and utilization by the target fish. Such feed should not only be firm to handling, but also be water stable in the aquatic environment and remain intact long enough for the fish to consume it (Pigott *et al.*, 1982; Pigott and Tucker, 1989; Wood, 1993). A minimum period of 20 minutes before serious leaching and disintegration in water medium was suggested (Pigott *et al.*, 1982).

If this is achieved, there will be optimum delivery of close to wholesome delivery and utilization of the compounded feed by the fish. In addition, the wastes generation potential of the feed is greatly reduced and this has been reported to be beneficial to aquaculture operation with respect to nutrient utilization (Sadiku and Jauncey, 1995, 1998).

In order to ensure feed stability in water, the role of binders as firming agents cannot be over-emphasized. Synthetic binders are of conventional use in aquaculture feed industry but they are often not available to fish farmers, thereby making the production of farm-made aquafeed difficult and equally not cost effective. Of great concern, is the level of such binders, which are yet to be established. However, Jauncey (1992) reported starch level of 0-20% inclusion in aquafeed.

There is inadequate research information on the use of cassava starch as binders and its attendant effects on feed quality. This study is therefore intended to investigate the suitability of on-farm extracted cassava starch as binder for farm-made aquafeed and its appropriate level of inclusion in such feed.

MATERIALS AND METHODS

Starch processing

One cassava tuber of the species *Manihot esculenta* was peeled, washed and grated. This was 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 later sun-dried for 6hrs and packaged.

Diet preparation and pelleting

Binder level in an existing isonitrogenous diet formula of 30% crude protein was reconstituted, with the use of cassava starch at inclusion levels of 0, 5, 10, 15 and 20% as Diets 1, 2, 3, 4 and 5 respectively (Table 1).

To ensure uniformity, the cassava starch was mixed in its raw form to other feed ingredients; 120% v/w boiled water was added and stirred thoroughly to obtain a good dough. This was fed to an Atlas motorized Bohr miller (Pelleter) and 3mm die was used for the pelleting. The pellet strands were cut at 5mm length, sun-dried for 6hrs and packaged. Ambient temperature of starch and pelleted feed sun-drying was an average of 36^0C.

Evaluation of Physical properties of the pellets

The following physical tests were conducted on the pellets, namely; pelletability, dust level, hardness, friability and water stability.

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

ii. **Hardness**
The procedure used was to determine the force required to cause a feed particle to fragment. It gives an indication of pellet hardness. An improvised pentagon nut was used thus; a pellet sample of 5mm in length was placed longitudinally between two rods and gently gripped. The pentagon nut was then turned sheared. This was repeated for 24 more pellets and average number of turns taken.

iii. **Friability**
Fifty grams (50g) of pellet sample was put in a container and adapted into a rotary machine at different preset speed levels (rpm) of 40, 63, 80 and 100rpms for 20minutes. The dust produced was sieved using 2mm sieve and weighed. It was expressed as a percentage of the sample weight.

iv. **Water stability**
Fifty grams (50g) of feed sample was placed in beaker into which 200m of tap water was added. It was then allowed to stand with occasional gentle shaking, i.e. for 20 seconds every 2 minutes, for 20 minutes. It was then passed over 22mm sieve and the material retained was sun-dried. The

Table 1. Percentage composition of diets with varying levels of cassava starch

Feedstuff	Diets 1	2	3	4	5
Soybean meal	37.26	37.26	37.26	37.26	37.26
Fishmeal	13.64	13.64	13.64	13.64	13.64
Corn bran	16.37	16.37	16.37	16.37	16.37
Guinea-Corn bran	32.74	32.74	32.74	32.74	32.74
Cassava Starch	0	5	10	15	20
Vitamin-mineral premis*	20	15	10	5	0
Proximate Composition					
Moisture	7.43	13.40	16.81	20.21	23.61
Cnide protein	28.91	28.91	28.91	28.91	28.91
Ether Extract	9.9	9.9	9.9	9.9	9.9
Ash	26.19	21.19	16.19	11.19	6.19

* Vitamin-mineral premix is as contained in Sadiku and Jauncey (1995 and 1998).

retained dry weight was then expressed as a percentage of the sample dry weight.

v. **Dust**

Sample pellet (50g) was placed under normal stress-condition, such as handling, packaging and transportation, for 2 weeks. The dust produced was then taken after sieving through 2mm sieve and measured as a percentage of the original sample weight.

EXPERIMENTAL DESIGN

Completely randomised block design was adopted for pelletability, hardness, dust and water stability evaluation while that of friability was a 5 x 4 factorial design of 5 starch levels in the diets by 4 levels of rpms.

STATISTICAL ANALYSIS

The analysis of the data was done using one-way analysis of Variance (ANOVA). Arc-sine data transformation was done according to Zar (1984). Means comparison was done using multiple range test (Steel and Torrie, 1960).

RESULT

Dust level percentage was found to differ significantly among the starch levels ($P<0.05$). It was highest in 5% and lowest in 15% starch level. Variation in the diets pelletability percentage also differed significantly ($P<0.05$). Diets with 5% and 20% starch level were the most pelletable while that with 15% starch was the least pelletable. Also, the percentage hardness varied significantly with the starch level ($P<0.05$). The diets containing 10% and 15% starch were hardest while that with 5% was least resistant to pressure. Differences in the water stability of pellets with respect to starch level was significant ($P<0.05$). The diets with 20% starch were the most water stable while the least water stable had 10% starch (Table 2).

Friability test showed that there was a significant difference among starch levels irrespective of the number of rotations per minute (rpm) ($p<0.05$). Significant difference was also observed among the rpms irrespective of starch level ($P<0.05$). Interaction between the starch levels and the rpms was insignificant ($P<0.05$). Friability percentage was highest at 80 rpm of 5% starch level and lowest at 40 rpm of 0% starch level (Table 3)

Table 2. Physical Parameters of cassava starch based diets

Parameter	0%	Starch 5%	Level 10%	15%	20%
Dust	0.12ab	0.15b	0.12ab	0.9a	0.10ab
Pelletability	90.11c	84.00b	55.00a	57.14a	93.46c
Hardness	5.16c	3.32	5.92d	5.80d	4.12b
Water Stability	46.03d	44.58a	45.92c	45.72b	46.87e

Table 3. Friability of cassava starch based diets

rpm	0%	Starch 5%	Level 10%	15%	20%
40	0.04a	0.13def	0.09abcde	0.05ab	0.07abc
63	0.07abc	0.17fg	0.12cdef	0.08abcd	0.07abc
80	0.09abcde	0.19g	0.11cde	0.07abc	0.12cdef
100	0.14efg	0.12cdef	0.17fg	0.10bcde	0.12cdef

DISCUSSION

It was observed that cassava starch as a binder performed best at 20% level of inclusion and worst at 5% level of inclusion. At 20% level, the pelletability was highest and the feed was most stable in water. This was due to the adequacy of the binder inclusion level desirable for good pelletability (Pond and Church, 1988; Hardy, 1989; Huang, 1989; Lim and Dominy, 1991). However, percentage hardness was low compared to level of inclusion at 10% and 15% respectively. Though, the pellets were hard at these levels, pelletability percentage were very low with high dust yield at 10% level of inclusion and low water stability for both levels compared with 20%.

At 10% level of inclusion, hardness, pelletability and water stability were high. The feed was observed to be high in dust yield but lower than that of 15% and higher than that of 20%. This can be attributed to starch inadequacy. Binder inadequacy has been reported to account for poor water stability of diets (Stivers, 1970; Hastings and Higgs, 1980; Akiyama *et al.*, 1989; Fagbenro and Jauncy, 1995). This was also reflected in the friability percentage, which was on the increase, with respect to number of rotation per minute of the container at 0% level inclsuion, but constant at 20%.

It can be concluded therefore that 20% level inclusion of cassava starch is most suitable for firm, pelletable and water stable feed. A good feed should be water stable with minimum leaching of water soluble component of the diet to ensure optimum utilisation of the feed (Jobling, 1994; De Silva and Anderson, 1995).

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