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Biotechnology Of Floating Feed Development

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Abstract:
The study was conducted on the Development of floating diets for catfish and tilapia fish species, involving a single cell organism and three non living additives as floaters, two indigenous starches and an organic hydro-colloid as binders. Physical, Bio-chemical qualities and Characteristics of Lemnapaucicostata(Duckweed), Honey comb (HC) , Saccharomyces cerevisiae(Sc) Baker's yeast floaters, Cooked and Uncooked Wheat flour starch (WFS), Cassava tuber starch (CTS) and Aquatec-11 binders were investigated and validated. Twenty one (28) is-proteic 30% Crude protein, is-caloric 37Kcal/g diets were produced with live and non-living additives formulated asproteins and lipids sources;the binders and other carbohydrate sources formed the energy sources of nutrients. The diets were developed intopellets, flakes and ball shapes and investigated for Flotation for one hour at 10 minutes interval. There were increases or buoyancy in balls and pellets which were attributed to the presence of gas and some distinguished nutrients in the floaters and binding agents involved in diets preparation. There was no significant difference (P>0.05) in Flotation of diets produced from cooked starches,the uncooked wheat flour starch and Aquatec-11 with S. cerevisiae, Lemnapaucicostata and Honey comb floaters in the first 30 minutes of trials. No flotation was observed in diets without floater. Subsequent research works (in other papers) revealed positive growth, feed utilization and survival in catfish and Tilapia fishes; all agents were therefore recommended for fish feed production

Key words: Binding Agents, Clariasgariepinus , Diets,Floating Feed, Floaters, Starches, , Oreochromisniloticus,Polymethylo-Cabarmide

1.Introduction

Floating feeds is hydrophobic and buoyant. The rate of leaching is low compared to conventional sinking feeds. The feeds nutrients are retained within the periods of float thereby enabling fish to consume whole feed (Kearns, 1989) within the floating periods. Though it's suitable for surface feeders, the benthic feeders are quickly assessed for activeness and healthiness at feeding (Ensmiger and Olentine, 1978). This is a management tool in aquaculture in that, the farmers has the precise knowledge about the mass of fish in pond (Mgbenka and Lovell, 1984). The development of on-farm floating feeds for fishes by the use of different floating and binding agents is about replacing or complementing the expensive expanded floating feeds produced by extrusion (NRC, 1983, Hoftman La-Roche, 1991 and Said, 1992).

2.Materials And Methods

2.1.Formulation Of Diets

The values of the floaters, starches/binders and other ingredients involved in the preparation of diets were determined as follows:

Fish meal was fixed in all diets at 10 %, minerals and vitamins premix fixed at 5%, vegetable oil fixed at 2% and common salt at 0.3%. The values of the starches/binders (CTS, MGS, WFS and Aquatec-11) and floaters (Lemna, Yeast and Honey comb) were determined as follows:

The main Plant protein feedstuff (GNC and ESBM) and the protein floating agents (Lemna and Yeast) were included in same ratio 1:1:1 and formulated along with the cooked and uncooked starches and synthetic binding agent (CTS, MGS, WFS and Aquatec-11). Honey comb was formulated as carbohydrate feedstuff and included in ratio 1:1 in all formulations. The values of the plant proteins, starches/binding agents and the protein feedstuff and floating agents mentioned above were determined by the equation methods as described by Halver, (1989) as seen in Table 1. The control diets were formulated with other starches and ingredients but were avoided of any of the floating agents. In all, 28 diets were produced which were isoproteic 30% crude protein and multi-caloric ranged from 21-40 Kcal/g^{100} for *Oreochromisniloticus*fingerlings (Eguia*et al,* 2004) and Clariasgariepinusfingerlings (Ayinla and Akande, 1988).

All feedstuff were milled and sieved to fine particulates. Individual diet was compounded by weighing the required quantity of ingredients with Aqua lab Electronic Digital

Sensitive Top Loading Balance Model 333, into a clean plastic bucket. The ingredients were first mixed in dry form before the prepared binding and floating agents were added. In all diets prepared, it was only the live agent (yeast) that was added last to dough, before vegetable oil. Similarly, Aquatec-11 (a synthetic binder with Polymethylo-cabarmide as major ingredient) was introduced in dry form to dough, before the vegetable oil as last ingredient in that diet preparation. In the others, the floating and binding agents were co-mixed along with other ingredients. Apart from water used in the preparation of the binders and floaters, additional 250 ml water was introduced in every 1000g dry feed compounded, in order to obtain the required dough texture. Thorough hand-kneading of dough was done until a little portion represents the whole parts of the mixture. This is to ensure homogenous mixture of all ingredients in diets.

INGREDIENTS g DM	DT1 CCTS	DT2 UCTS	DT3 CMGS	DT4 UMGS	DT5 CWFS	DT6 UWFS	DT7 AQUAII	DT8 CCTS	DT9 UCTS	DT10 CMGS	DT11 UMGS	DT12 CWFS	DT13 UWFS	DT14 AQUAII
CTS	30.38	30.78	0.00	0.00	0.00	0.00	0.00	31.80	32.22	0.00	0.00	0.00	0.00	**0.00**
MGS	0.00	0.00	36.17	36.00	0.00	0.00	0.00	00.00	00.00	37.67	37.50	0.00	0.00	**0.00**
WFS	0.00	0.00	0.00	0.00	44.70	43.02	0.00	0.00	0.00	0.00	0.00	46.00	44.52	**0.00**
Aqua-II	0.00	0.00	0.00	0.00	0.00	0.00	29.03	0.00	0.00	0.00	0.00	0.00	0.00	**30.01**
GNC	17.44	17.31	15.51	15.57	12.66	13.23	17.86	16.97	16.83	15.06	15.07	12.17	12.13	**17.56**
ESBM	17.44	17.31	15.51	15.57	12.66	13.23	17.86	16.97	16.83	15.06	15.07	12.17	12.13	**17.56**
Lemna floater	17.44	17.31	15.51	15.57	12.66	13.23	17.86	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
YEAST floater	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.97	16.83	15.06	15.07	12.17	12.13	**17.56**
FISH MEAL	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	**10.00**
*PREMIX	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	**5.00**
VEGETABLE OIL	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	**2.00**
NaCl	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30

INGREDIENTS G	DT15 CCTS	DT16 UCTS	DT17 CMGS	DT18 UMGS	DT19 CWFS	DT20 UWFS	DT21 AQUAII	DT22 CCTS	DT23 UCTS	DT24 CMGS	DT25 UMGS	DT26 CWFS	DT27 UWFS	DT28 AQUAII
CTS	17.86	16.66	0.00	0.00	0.00	0.00	0.00	27.68	27.31	0.00	0.00	0.00	0.00	0.00
MGS	0.00	0.00	20.03	21.38	0.00	0.00	0.00	0.00	0.00	33.29	32.74	0.00	0.00	0.00
WFS	0.00	0.00	0.00	0.00	22.29	22.81	0.00	0.00	0.00	0.00	0.00	40.06	41.75	0.00
AQU-II	0.00	0.00	0.00	0.00	0.00	0.00	13.92	0.00	0.00	0.00	0.00	0.00	0.00	25.83
GNC	23.50	24.85	21.32	19.97	19.06	18.54	22.91	27.51	27.31	24.71	25.00	21.32	20.47	28.43
ESBM	23.50	24.85	21.32	19.97	19.06	18.54	22.91	27.51	27.31	24.71	25.00	21.32	20.47	28.43
Honey Comb floater	17.86	16.66	20.03	21.38	22.29	22.81	22.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fish Meal	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
*Premix	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Vegetable Oil	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
NaCl	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30

Table 1: Diets Formulated With Different Floating Agents And Controls (G)

*(Premix provides the following vitamins and minerals per gram of diet (or per 100 kg). Vitamin A: 45.00 I U; Vitamins D3: 1125 IU; Vitamin E: 7 IU; K3: 2 mg, B12: 0.015 mg; Pantothenic acid: 5 mg; Nicotinic acid: 14 mg; Folic acid: 0.4 mg; Biotin: 0.04 mg; Choline: 1.50 mg; Cobalt: 0.2 mg; Copper: 4,5 mg; Iron: 21 mg; Manganese: 20 mg; Iodine: 0.6 mg; Selenium: 22 mg; Zinc: 20 mg; Anti oxidant: 2 mg).

PARAMETERS	DT 1	DT 2	DT 3	DT 4	DT 5	DT 6	DT 7	DT 8	DT 9	DT 10	DT 11	DT 12	DT 13	DT 14
MOISTURE (%)	6.00 ±1.32	5.80 ±1.20	6.40 ±1.00	6.10 ±1.32	6.50 ±1.22	6.00 ±1.32	5.50 ±1.20	6.50 ±1.00	6.50 ±1.22	6.50 ±1.20	6.80 ±1.24	6.60 ±1.22	6.20 ±1.40	5.50 ±1.30
CRUDE PROTEIN (%)	30.01 ±1.82	30.01 ±1.81	30.01 ±1.80	30.02 ±2.20	30.30 ±2.02	30.01 ±1.82	30.01 ±1.86	30.00 ±1.90	30.01 ±2.10	30.00 ±2.00	30.01 ±2.02	30.00 ±1.80	30.00 ±2.00	30.01 ±2.02
CRUDE LIPID (%)	12.70^{c} ±0.02	12.7^{c} ±0.12	12.7^{c} ±0.20	12.7^{c} ±0.20	12.5^{c} ±0.22	12.5^{c} ±0.20	13.4^{c} ±0.22	12.5^{c} ±0.21	12.3^{c} ±0.22	12.6^{c} ±0.20	12.5^{c} ±0.22	12.0^{c} ±0.18	12.2^{c} ±0.24	13.6^{c} ±0.22
CRUDE FIBER (%)	4.7^{a} ±1.10	5.0^{a} ±1.02	4.0^{a} ±1.12	4.2^{a} ±1.10	4.5^{a} ±1.20	4.5^{a} ±1.12	7.9^{b} ±1.20	4.7^{a} ±1.22	4.7^{a} ±1.22	4.5^{a} ±1.20	4.4^{a} ±1.20	5.0^{a} ±1.30	5.1^{a} ±1.22	8.0^{b} ±1.40
ASH CONTENT (%)	6.9^{a} ±1.22	6.9^{a} ±1.32	6.6^{a} ±1.30	6.8^{a} ±1.26	5.9^{a} ±1.29	6.5^{a} ±1.28	21.5^{b} ±1.26	6.2^{a} ±1.24	6.5^{a} ±1.20	6.4^{a} ±1.20	6.3^{a} ±1.30	6.4^{a} ±1.22	6.2^{a} ±1.60	21.5^{c} ±1.40
NFE (%)	39.6^{a} ±1.10	39.5^{a} ±0.50	40.2^{a} ±1.10	40.1^{a} ±1.32	40.0^{a} ±1.20	40.2^{a} ±1.40	21.6^{b} ±1.40	40.1^{a} ±1.66	39.9^{a} ±1.10	39.9^{a} ±1.10	39.9^{a} ±1.10	40.1^{a} ±1.30	40.3^{a} ±1.40	21.3^{b} ±1.42

PARAMETERS	DT 15	DT 16	DT 17	DT 18	DT 19	DT 20	DT 21	DT 22C	DT 23C	DT 24C	DT 25C	DT 26C	DT 27C	DT 28 C
MOISTURE (%)	4.50 ±1.22	4.40 ±1.20	4.50 ±1.32	4.40 ±1.30	4.60 ±1.40	4.50 ±1.42	6.3 ±1.32	4.60 ±1.40	4.50 ±1.38	4.45 ±1.34	4.20 ±1.42	4.50 ±1.32	6.00 ±0.32	5.50 ±1.42
CRUDE PROTEIN (%)	30.00 ±1.82	30.00 ±1.70	30.00 ±1.88	30.00 ±2.00	30.01 ±1.68	30.00 ±2.00	30.00 ±1,88	30.00 ±1.92	30.01 ±2.00	30.01 ±2.00	30.00 ±1.88	30.00 ±2.44	30.01 ±2.80	30.00 ±1.60
CRUDE LIPID (%)	20.00^{b} ±1.00	20.1^{b} ±1.02	21.2^{b} ±1.00	20.9^{b} ±1.00	21.2^{b} ±1.02	21.5^{b} ±0.50	21.0^{b} ±1.01	16.43^{a} ±2.00	16.4^{a} ±2.00	15.33^{a} ±2.20	15.2^{a} ±2.20	15.15^{a} ±1.82	15.1^{a} ±2.00	16.14^{a} ±1.80
CRUDE FIBER (%)	5.1^{a} ±2.00	5.2^{a} ±2.00	4.9^{a} ±2.00	4.8^{a} ±1.10	4.5^{a} ±2.10	4.4^{a} ±2.00	7.0^{b} ±1.80	5.0^{a} ±2.00	5.1^{a} ±1.80	4.8^{a} ±2.00	4.8^{a} ±2.00	4.6^{a} ±1.60	5.1^{a} ±2.00	7.9^{b} ±2.00
ASH CONTENT (%)	5.0^{a} ±1.22	5.2^{a} ±1.20	5.4^{a} ±1.20	5.5^{a} ±1.12	5.7^{a} ±1.02	5.6^{a} ±1.10	14.4^{a} ±0.22	5.8^{a} ±1.20	5.7^{a} ±1.10	5.8^{a} ±1.00	5.7^{a} ±1.00	5.6^{a} ±1.12	5.6^{a} ±1.10	18.7^{b} ±1.10
NFE (%)	35.4^{a} ±0.10	35.1^{a} ±0.10	34.9^{a} ±0.10	34.3^{a} ±0.20	33.9^{a} ±0.10	33.9^{a} ±1.10	21.3^{b} ±1.10	38.2^{a} ±1.10	38.2^{a} ±1.10	39.6^{a} ±0.10	39.9^{a} ±0.05	39.6^{a} ±0.24	39.6^{a} ±0.40	22.3^{b} ±1.20

Table 2: Proximate Composition Of Diets (±Sem) On % Dry Matter Bases

Values in rows with different superscript are significantly different ($P<0.05$)

3.Diets Shapes Development

A portion of feed-dough was placed in a Project Development Agency (PRODA) made pelletizer (model 1989), and rolled out through 4mm die holes into a galvanised waiting tray coated with oil film (Plate 1) to prevent adhesion. The wet pellets were arranged in the galvanised trays and manually cut fresh with razor blade into 2cm (Plate 2)each.

The tray was covered with the tray lid and fold up inside a thick Jean clothing material (Plate 3) and kept in a warm room where it under-went maturation (fermentation) for three hours. The matured pellets were placed in electric oven (Plate 4) to dry at 60^{o}C for 3 hours.

Plate 1: Pelleting of diets dough with PRODA made Pelletizer into oil-filmed galvanised tray.

Plate 2: Cutting of strands into equal (2cm) cylindrical or pellet sizes with a rule

Plate 3: Covering of Diets to undergo maturation for three hours

Plate 4: Oven-drying of Diets

The cut pellets represent cylindrical or pellet shape(Plate 5)

4.Formation Of Other Shapes

Some of the fresh pellets cut into 2cm sizes were further placed on a flat plastic glass sheet and flattened with empty bottle to form flat shapes (Plate 6) which are the improvised flakes. The flakes were further placed in oil film lining tray, covered with lid, fold up in jean and kept to mature for three hours; and oven-dried as described earlier.

Round or Ball shape diets:Some of the fresh 2cm pellets were also hand-moulded to ball shape(Plate 7), placed in the tray with oil film and covered with the lid, fold up in clothing material and allowed to undergo maturation for same period and oven-dried. All diets underwent maturation (fermentation) to ensure equal treatments of samples. The dried pellets, flakes and balls were kept in sealed polythene bags. Samples were sent in sealed bottles for proximate analysis and flotation trials.

Plate 5: Dried Cylindrical or Pellet shape diets

Plate 6: Flat or Flake shape diets

Plate 7: Round or Ball shape diets

5.Test For Flotation

Borehole water was filled to ¾ holding capacity of a rectangular glass tank of dimension 60 x 30 x 30 cm. Aeration was done through electric aerators and air stones. Three replicates samples (20) of each diet shape were dropped inside the water in the glass tank **(Plate 8)** and observed for flotation for one hour (60 minutes) at 10 minutes interval following the methods of Falayi*et al*, (2004). The numbers of diets afloat were recorded as the numbers that have completed flotation at that time interval. The numbers of floating diets were expressed as a percentage of the whole numbers placed at the initial

Plate 8: Testing of Pellets and Ball shapes diets for flotation in glass tanks.

6.Results And Discussion

6.1.DietsComposition

The proximate analyses of the 28 diets are shown in Table 2. The crude protein ranged from 30.10-30.48%. There were no significant differences (P>0.05) in the protein content of diets. Crude lipid ranged from 12.00 to 21.49% with the highest in Honey comb based diets which were significantly different (P<0.05) from diets produced from other floaters and controls. Fiber content ranged from 4.01 to 8.00% with highest in Aquatec-II diets and were significantly difference ($P<0.05$) from others. Ash contents ranged from 5.00 to 21.55% with the highest in Aquatec-11 agent and were also significantly different ($P<0.05$) from the other diets. Moisture contents range from 4.20 to 6.8% in all diets and were not significantly different ($P>0.05$) from diets. Crude lipids in diets produced with Lemna and Yeast floaters were also significantly different ($P<0.05$) from each other. NFE was significantly ($P<0.05$) lower in the diets produced from Aquatec-11 synthetic agent.

The little disparities in the proximate composition of the twenty eight diets as shown in Table 2 could be as a result of the differences in the nutrients compositions of the different floating and binding agents involved in diets formulation, or due to the variation in nutrients composition of other feedstuffs in diets development. The lipid and carbohydrate energy in diets were fairly high and would improve feed buoyancy and growth of fish (Teshima*et al,* 1993) and further enhance binding potentials of diets and prevent early disintegration of diets in water (Mitchell, 1979). High dry matters were obtained in all diets which signified low moisture content and good preservation for the diets.

There were increases in the size of diets after maturation. This may be due to gluten and other proteins (in diets) interaction with lipids (in diets).Pomeranz and Chang (1978) reported that in dough making and diet preparation, between 30 -70% of non-polar lipids and practically all polar lipids interact with gluten fibbers' and to a lesser degree, with other cereal proteins by both hydrophobic and hydrophilic bonds and that Starch-glycol-lipid-gluten complexes are formed. The additional 2% vegetable oil in formulation (Table 1) increases the dough's volume and also improves the crumb quality (Bell *et al,* 1977) mainly due to physical phenomena. The oil also assisted the increase in the retention of carbon dioxide (CO_2) gas produced by maturation (fermentation) processes in the case of the yeast (live agent) floated diets, and further staged of rapid expansion seen in other diets.

The increase in size of diets from the live (Yeast) floater after maturation was accompanied with air filled spaces and the related fermentation flavour. This was possible because part of the starch in ingredients that formed the diets dough were converted to sugar, capable of being fermented by the yeast to alcohol with the simultaneous release of carbon-dioxide gas. The CO_2 gas gave the dough the increase in size with porous structure ((Oda and Ouchi, 1989, Watanabe *et al,* 1990). The properties of the starches ability to coat or seal the diets and prolong entrapment of the carbon-dioxide gas, lipid, proteins and fibers in diets as well as prevention of water from penetrating the diets to cause early disintegration (Gluclick and Shelef, 1962) were observed in this process. The diets without yeast also had some increase in size. The increment in Honey comb diets may be as a result of the quantity of the comb involved in diets formulation and high lipids content in the diets (Table 2) with starch and gluten interactions and the complexes formed.

The increase in Lemna diets could be due to the quantity of duckweed in formulation (Table 4) and its abundant cellulose content and air filled spaces within the cells (Mbagwu and Adeniji, 1988), the gluten protein and other protein fibers (Ihekoronye and Ngoddy, 1985). The lipids and cellulose in the diets were trapped and sealed by the starch and same glyco-lipid-gluten complexes.

7.Diets Flotation

The results on Flotation capabilities of the diets including the control are presented in Table 3. The results showed that all diets bound with synthetic agent (Aquatec-11) were highest (100 %) in flotation from 10 to 60 minutes of trials irrespective of floating agent involved except those without floaters.

Among the local starches, all diets produced from uncooked Wheat flour starch (UWFS) and the floating agents (Yeast, Duckweed and Honeycomb) floated. Diets 1, 5, 6, 8, 13 and 20 produced from the local starches were not significantly different (P>0.05) from diets containing Aquatec-11agent in the first 20 minutes of trial. Diets 6 and 13 which were produced from UWFS + LM and UWFS + YT respectively, were not significantly different (P>0.05) from diets containing Aquatec-11 from 30 minutes to end of trial. Diets 2 and 4 produced from the other uncooked starches (UCTS and UMGS) only produced floatation in Duckweed agent among floaters and were significantly different (P<0.05) from Honey comb and Yeast from ten minutes to end of immersion. All diets produced without floater (controls) did not float despite the incorporation of the starches apart from Aquatec-II which is a synthetic binder which floated only at 25% in the first 10 minutes of trial.

Among the cooked starches, the highest flotation was observed in Diet 13 (CWFS + YT) with floatation reduced with time from 95.00 - 81.00% from 10 to 60 minutes. This was followed by Diet 6 (UWFS + LM) with 90.10 to 80.00% within the same time frame. Diets 20 (UWFS+ HC) and 8 (CCTS + YT) with 89.00 to 55.00% were next. Diets 1

(CCTS + LM), 19 (CWFS + HC) and 5 (CWFS + LM) obtained 80.5 to 50.00%, 75.00 to 15.00% and 80.00 to 10.00% flotation, respectively in that order. The reason may be due to the fact that cooking causes gelatinization and pre-gelatinized wheat starch and other cereal products are highly hygroscopic, very viscous and hence good binding abilities (Glucklick and Shelef, 1962, Mitchell, 1979) that assisted the sealing of air spaces, lipids, proteins and cellulose passages and therefore influence buoyancy or flotation in those diets. Flotation in cooked cassava starch with Lemna and Yeast, cooked and uncooked wheat flour starch with Lemna, yeast and Honey comb were not significantly different (P>0.05) from those bond with synthetic binder in the first 20 minutes of immersion. Furthermore, flotation in diets produced from UWFS with Yeast and Lemna agents were not significantly different (P>0.05) from all other floaters bound with Aquatec-11 from 30 to 50 minutes.

The least floatation was recorded in Diet 4 (UMGS + LM) with 40.00, 15.00 and 0% floatation in 10, 20 and 60 minutes respectively. Zero floatation was observed in Diets 9, 11, 16, 18 produced from uncooked cassava tuber starch with Yeast (UCTS + YT), uncooked maize grains starch with Yeast (UMGS + YT), uncooked cassava tuber starch with Honey comb (UCTS + HC) and uncooked maize grain with Honey comb (UMGS + HC), respectively.

8.Diets Shapes And Flotation

Among the three shapes (Cylindrical/Pellets, Flats and Balls) producedthe cylindrical and ball diets floated with Aquatec-II synthetic binder. This could be because the binding agent is a polymer product with high quality viscosity and binding potentials than the local starches. Polymers have ability to lock air in spaces within diets, while starches because of their low grade viscosity may loosen the gas which would have aided flotation as soon as pellets enter waters. Only few seconds flotation were observed in the cylindrical shape (pellets) with other starches, because air bubbles were noticed coming from both ends where pellets disengaged (cut off) from each other during pellets development. The reason for air leakages may be traced to the inferior sealing potentials of the local starches (MGS, WFS and CTS).

The flats or flakes shaped produced from Aquatec-11 agent and all starches did not float on water. The major reason could be due to the large surface area of the flat shape diet which cover large expanse water surface. Archimedes principle on flotation mentioned large surface area coverage by an object does not support such object's floatation or that it's negatively impaired flotation (McGraw-Hill, 1982).

The ball shape diets floated on water, possibly because the synthetic and local binders were able to seal the diets with the embedded lipid content within; the insolubility of lipid, the springing gluten and other protein fibres and their complexes formed within diets. In all tested diets, percentage flotation was highest (P>0.05) in diets bond with the synthetic agent (Aquatec-11). The high flotation can be traced to the fact that, Aquatec-II contained Polymethylo-cabarmide as major ingredient. Polymers are known for their high viscosity grade, high molecular weight and high coating abilities (than local starches) which therefore prevent early leaching and disintegration of the diets. Polymethylo-cabarmide enters starch particles (amylase) and form complexes with amylase. Amylase is prevented from migrating outside the resultant compound, and the rigid matrix of the complex formed increases the resistance of starch gel against staling (Greveland, 1973). Amylase-Polymethylo-cabarmide complex is supposed (Lagendijk and Pennings, 1970) to be an inclusion compound in which the two components are bond by physical forces (Mac Ritchie, 1980). The reaction of polymers on starch particles in forming complexes with amylase help the sealing of air passages, enclosure of embedded lipids and gluten protein in diets and thereby assisted the subsequent buoyancy and flotation for longer times.

9.Diets Flotation as related to the Floating Agents

There were flotations in diets produced from Duckweed agent in all uncooked starches. This could be the fact that Duckweed contains binding properties (Bairagi*et al,* 2003) which like the starches had helped the sealing of air and nutrients passages and subsequent diets flotation. Duckweed diets also recorded the highest flotation among other floaters. The inherent binding properties, coupled with higher dry matter, lipids, and air filled spaces within its cells (Mbagwu and Adeniji, 1988) supported the flotation in duckweed diets.

Yeast *S*. cerevisiae based diets generally had higher percent flotation in all cooked starches, uncooked wheat and Aquatec-11 binder. The air filled spaces during maturation or fermentation of dough, the springing product of gluten proteins from wheat and other proteins Fibers and the lipid in the diets must have led to diets buoyancy and the subsequent floating potentialities on water surface. The addition of 2% vegetable oil also assisted the increase in size of dough's and carbon dioxide (CO_2) gas retention within diets; for those periods of flotation.

The high floating capabilities of Honey comb diets could be due to honey comb physical buoyancy in water and high percentage inclusion in diet, its wax or lipids content and high percentage dry matter. These features have assisted the binding and the suspension of diets on water surface. The high flotation value could further be to the non-saturation of oil and the insolubility of the natural wax (lipids) in honey comb and the diets which Langdon and Bolton(1984) and Teshimaet al (1993) had earlier reported. These authors affirmed the importance of lipids insolubility (except in ether) in the development of lipid wall capsules for the delivery of high molecular weight water soluble nutrients such as proteins, lipids, vitamins and minerals larvae of fish

DIETS CODE/NO	**10**	**20**	**30**	**40**	**50**	**60**
LM + CCTS DT 1	80.50 ^{a}	80.00 ^{a}	65.00 ^{b}	60.00 ^{b}	55.00 ^{c}	50.00 ^{c}
LM + UCTS DT 2	60.20 ^{b}	25.00 ^{d}	10.00 ^{e}	0.00	0.00	0.00
LM + CMGS DT 3	55.10 ^{c}	40.00 ^{b}	20.00 ^{e}	5.00 ^{e}	0.00	0.00
LM + UMGS DT 4	40.00 ^{b}	15.00 ^{e}	5.00 ^{e}	0.00	0.00	0.00
LM + CWFS DT 5	80.00 ^{a}	80.00 ^{a}	50.00 ^{c}	45.50 ^{c}	30.10 ^{d}	10.00 ^{e}
LM + UWFS DT 6	90.50 ^{a}	88.40 ^{a}	86.00 ^{a}	82.90 ^{a}	80.50 ^{a}	80.00 ^{a}
LM + AQU-II DT 7	100.00 ^{a}	100.0 ^{a}	100.0 ^{a}	100.0 ^{a}	100.0 ^{a}	100.00 ^{a}
YT+ CCTS DT 8	89.00 ^{a}	80.00 ^{a}	70.00 ^{b}	68.00 ^{b}	60.50 ^{b}	55.00 ^{c}
YT+ UCTS DT 9	0.00	0.00	0.00	0.00	0.00	0.00
YT + CMGS DT 10	50.00 ^{c}	40.20 ^{c}	15.00 ^{e}	5.00 ^{e}	0.00	0.00
YT + UMGS DT 11	0.00	0.00	0.00	0.00	0.00	0.00
YT + CWFS DT 12	75.00 ^{b}	50.00 ^{c}	45.00 ^{c}	40.10 ^{c}	35.00 ^{d}	30.00 ^{d}
YT + UWFS DT 13	95.00 ^{a}	88.00 ^{a}	84.50 ^{a}	82.70 ^{a}	82.00 ^{a}	81.00 ^{a}
YT + AQU-II DT 14	100.00 ^{a}	100.0 ^{a}	100.0 ^{a}	100.0 ^{a}	100.0 ^{a}	100.00 ^{a}

DIETS CODE	10	20	30	40	50	60
HC + CCTS DT 15	75.00 [b]	50.00 [c]	40.00 [c]	30.00 [d]	20.00 [e]	10.00 [e]
HC + UCTS DT 16	0.00	0.00	0.00	0.00	0.00	0.00
HC + CMGS DT 17	50.00 [c]	45.00 [c]	35.00 [d]	30.00 [d]	20.00 [d]	10.00 [e]
HC + UMGS DT 18	0.00	0.00	0.00	0.00	0.00	0.00
HC + CWFS DT19	75.00 [b]	65.00 [b]	55.00 [c]	30.00 [d]	20.00 [d]	15.00[e]
HC + UWFS DT20	90.00 [a]	85.00 [a]	70.00 [b]	62.00 [b]	50.00[c]	50.00 [c]
HC + AQU-II DT 21	100.00 [a]	100.0 [a]	100.0 [a]	100.0 [a]	100.0 [a]	100.0 [a]
CCTS WITHOUT FLOATER DT 22C	50.00 [c]	40.00 [c]	20.00 [d]	10.00 [e]	0.00	0.00
UCTS WITHOUT FLOATER DT 23C	0.00	0.00	0.00	0.00	0.00	0.00
CMGS WITHOUT FLOATER DT 24C	0.00	0.00	0.00	0.00	0.00	0.00
UMGS WITHOUT FLOATER DT 25C	0.00	0.00	0.00	0.00	0.00	0.00
CWFS WITHOUT FLOATER DT 26C	0.00	0.00	0.00	0.00	0.00	0.00
UWFS WITHOUT FLOATER DT 27C	0.00	0.00	0.00	0.00	0.00	0.00
AQU-II WITHOUT FLOATER DT 28C	25.00 [d]	0.00	0.00	0.00	0.00	0.00

Table 3: % FLOTATION OF DIETS WITH FLOATERS AND CONTROLS.

TIME (Min.)

Values in column with different superscript are significantly different ($P<0.05$).

10.Reference

1. AOAC (Association of Official Analytical Chemists) (1990): Official Methods of Analysis (15th edition) Inc. Arlington, Virginia. 1054 pp
2. Ayinla, O.A. and Akande, G.R. (1988): Growth response of C. gariepinus (B) on silage based diets. Nigerian Institute of Oceanography and Marine Research (NIOMR). Technical Paper No.37, Lagos.
3. Bairagi, A., SarkarGhosh, K., Sen, S.K. and Ray, A.K. (2002): Duckweed (Lemnapolyrrhiza) leaf meal as a source of feedstuff in formulated diets rohu (Labeorohita Hum.) fingerlings after formulation with a fish intestinal bacterium. Bioresource Technology 85 (1): 17-23.
4. Bell, B.M; Daniels, D.G.H. and Fisher, N. (1977): Food Chemistry, 2:57 Cited in Chemical changes during food processing. Development in Food Science 21 (Edited by J. Davidek, J. Velisek J. and Pokorny, J.) Elsevier Public., New York.
5. Eguia, V. Ruel, Rowena, M. A., and Eguia, Romana (2004): Tilapia farming in cages and ponds. SEAFDEC, Aquaculture Department, Tigbanun, Iloilo, Philippine Aquaculture Extension Manual No 36, pp 24-25.
6. Ensminger, M.E. and Olentine C.G. Jnr. (1978): Feeds and Nutrition Edited by Ensminger Publication Corporation, California.
7. Eyo, A.A, Falayi, B.A.; and Oduba, I.A. (2003): Evaluation of extruded soybean meal (Glycine max) in the diets of catfish hybrid (Clariasanguillaris x Heterobranchuslongifilis) Journal of Sustainable Tropical Agriculture Research 7: 52-55.
8. Fasakin, E.A., Falayi, B.A. and Eyo, A.A. (2000): Inclusion of poultry manure in diets for Nile tilapia (O.niloticus, Linnaeus). Journal of Fish Technology 2:51-56.
9. Falayi, B.A., Balogun A.M., O.T. Adebayo and C.T. Madu (2003): Comparison of seven locally prepared starches with sodium carboxymethyl-cellulose for water stability in African catfish (C. gariepinus) feed. Journal of Sustainable Tropical Agriculture 9: 104 – 108.
10. Falayi, B.A., Balogun, A.M, Adebayo, O.T., Eyo, A.A. and Madu, Madu C.T. (2004): Leaching of feed Nutrients, economic losses to fish farming. Journal of Aquatic Science 18(2): 119-123.
11. B.A. Falayi, S.O.E. Sadiku, A.N. Okaeme and A.A. Eyo. (2004): Preliminary Investigation into the implication of single cell organism in fish feed buoyancy

and flotation. In proceedings: 19th Annual Conference, FISON, Ilorin, Kwara State. (Araoye P.A. ed.) pp 493-499.

12. Glulklick, J. and Shelef, L. (1960): An investigation into the rheological properties of flour dough. Studies in Shear on Compression.Cereal Chemistry.39:242 Pp.
13. Greveland, A. (1973): Lipids 8, (599).In-Chemical changes during food processing. Development in Food Science 21 (Edited by J. Davidek, J. Velisek, J. and Porkorny, J.).Elsevier Publication. 175pp.
14. Halver, J.E. (1976): Formulating practical diet for fish. Journal of Fisheries Research Board, Canada, 33: 1032-1039.
15. Hashim, R. and Saat, M.A. M. (1992): The utilization of seaweed meals as binding agents in pelleted feeds for Snakehead, Channastriatus fry and their effects on growth. Aquaculture, 108: 299-308.
16. Heinen, J.M. (1981): Evaluation of some binding agents for Crustacean diets. Progressive Fish Culturists, (43): 3: 145-5.
17. Hoftman-LaRoche (1991): Vitamins fortification recommendation update. Paramus, New – Jersey. 15pp
18. Ihekoroye, A.I. and Ngoddy, P.O. (1985): Integrated Food Science and Technology for the Tropics. Macmillan Publishers Ltd. London and Basingstoke.Pp 99-120
19. Kearns, J.P. (2004): Advancements in dryings, cooling and coatings systems for Aquatic feeds. International Aquaculture Feed.The International Resource Guide 2004.Pg 24-36
20. L'agendijk, J., and Pennings, H.J. (1970): Interaction of lipids with aqueous medium during food processing. Cereal Science Today 15: 329-354.
21. Langdon, C.J.and Bolton E.T. (1984): A micro-particulate diet for a suspension feeding bivalve mollusc (Crassostredvirginica (Gmelin.). Journal of Experimental Marine Biology and Ecology 82, Pp 235 –258.
22. Mac Ritchie, F. (1980): In Advances in Cereal Science and Technology, Vol. III (edited by Pomeranz, Y.,) St. Paul, America Association of Cereal Chemists, 271pp.
23. McGraw- Hill, (1982): Archimedes' principle on flotation and buoyancy. Encyclopaedia of Science and Technology. Sybil P. Parker (editor), 685-686.

24. Mgbenka, B.O. and Lovell, R.T. (1984): The Progressive Fish Culturist. Vol. 46(4).
25. Mbagwu, I.G. and Adeniji, H.A. (1988): The nutritional content of duckweed (Lemnapaucicostata. Heglenerenglem) in the Kainji Lake Area.Aquatic Botany 29:351-366.
26. Mbagwu, I.G. and Okoye, F.C. (1984): Preliminary reports on the utilization of duckweed Lemnapaucicostata by Tilapia Sarotherodongalilaeus. NIFFR Annual Report, Pp 33-45.
27. National Academy of Sciences (1976): Making Aquatic weeds useful. Some perspectives for Developing countries. Washington, D.C. 175pp.
28. NRC (1983): National Research Council, Nutrient requirements of warm-water fishes and shellfishes. National Academy Press, Washington, D.C, 102p.
29. Oda, Y. and Ouchi, K. (1989): Principal component analysis of the characteristics desirable in baker’s yeasts. Applied Environmental Microbiology 55:1495.
30. Orire, A.M., Sadiku, S.O.E. and Tiamiyu, L.O. (2001): Suitability of cassava (Manihotesculenta) starch as feed binder. Science Forum: Journal of Pure and Applied Science 4(1) 61-65.
31. Said N.W. (1992): Feed Extrusion, Triple “F” Ph. D. Linc. Douglas Avenue, Des Moines I.A. Ph. D. Thesis 7-101.
32. Teshima, S., Kanazawa A. and Koshio, S. (1993): Recent developments in nutrition and micro-encapsulate diets of larvae prawn. Israeli Journal of Aquaculture - Bamidgeh, 45: 175-184.