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EFFECT OF FORMULATION AND DIE SIZE ON FLOATABILITY AT DIFFERENT MOISTURE CONTENTS

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ABSTRACT

An existing single screw fish feed extruder was modified and used to analyze the effect of formulation and die size on floatability at different moisture contents (16, 20, 24, 28 and 32%). Before extrusion, feeds were compounded, formulated and extruded while the moisture contents of the extrudates were evaluated. Feed materials were finely ground and weighed to derive the required proportions. Each material for the formulation to be tested was thoroughly mixed manually. Sourced feed materials of ten formulations were extruded from the modified extruder. Water was poured into the mixture for proper mixing before it was fed into the extruder. The characterizations of the extruded feed were determined by measuring the following parameters; the moisture content and floatability. The floatability of extrudates produced using 3 mm and 4.5 mm die were compared and it was observed that feeds from formulation 2 had the highest overall floatability followed by the feeds from formulation 3 for both dies. Conclusively, formulations 2 and 3 had the highest level of floatability using 3mm die at 16% and 28% M.C respectively.

KEYWORDS: Floatability; Die sizes; Extruder; Moisture Contents; Extrudates

INTRODUCTION

Feed is responsible for 60 – 80% of the total cost of production in aquaculture (Eyo, 2001), and this has necessitated the growing interest in the use of cheap non-conventional feedstuff in fish nutrition in Nigeria. The need to formulate fish feeds with cheap and locally available feed resources that are not in direct competition with human foods has been widely accepted (Kekeocha et al., 2005). The formulation of fish feed in a country deficient of food grains adds greater challenge to nutritionists who must find cheap unconventional feedstuff for fish. Fish meal, which is one of the richest sources of protein used in aquatic feeds; because of its good amino acidic balance, high palatability, and growth performance has continually increased its demand for the supply of wild fish which invariably has steadily increased fish meal prices (Ayadi et al., 2013). It contains oil due to its high biological values in terms of essential amino acid, unsaturated fatty acids, minerals, and phospholipids for fish metabolism, which comes largely from wild fish stocks (Cheng et al., 2004). In general, anywhere from 2 to 6 pounds of ocean fish must be used to produce only one pound of farm-raised fish, resulting in 25% average transfer efficiency (MATF, 2007).

Most fish feed pellet in the market is low in terms of water stability and can pollute the pond water when it is immersed in it. Thus, the soluble vitamins and minerals will be easily leached out from the pellet. These will lead to the nutrient deficiency and environmental problems in fish tanks or ponds (Saalah et al., 2010). Extruded floating feed cost is a significant disadvantage over locally produced dried and moist pellets. The actual extruding machine for floating feed such as Insta PRO 2000 is very expensive and all efforts to procure the machine by the National Agricultural research Project (NARP) during the World Bank Project in 1900's proved abortive. This has led Nigerian`s permanent buyers of expanded floating feeds at high cost from international countries, to extrude feed locally with less dependence on international feeds (Adekunle et al., 2012). To get water stability which has a better floating time and lower leach ability, palm oil stearic can be added as a main subject compound.

MATERIALS AND METHOD

Experimental Feed Formulations

Extensive formulations optimization was carried based on the materials readily available to derive various feeds formulations. Formulations of the extruded feeds were calculated individually and the effect of feed materials and formulations on the extrusion process and floatability of extruded feeds were investigated. Six formulations were derived to suit recommended fish feed nutritional requirements while low density and low cost was made the objective functions. Various feed ingredients were used to compound these formulations. The feed materials were finely ground and weighed to derive the required proportions. Each material for the formulation to be tested was thoroughly mixed manually. The locally sourced feed materials of ten formulations were extruded from the designed and modified extruder. Water was introduced into the mixture for proper mixing before it was introduced into the extruder. The extruded feeds of the different formulations were evaluated and comparative analysis of all the compounded formulations were carried out to check for variations in floatability and cost.

Plate 1: Manual mixing of the formulated feed before extrusion

Out of the six formulations of fish feed extruded, four of them floated. An existing extruder was modified and was used to extrude the different formulated floating fish feeds at different moisture contents and die sizes (3 and 4.5 mm respectively). The exploded view of the modified extruder is shown in Figure 1 while the floatability test is shown in plate 2 below. A constant feed per formulation of 1 kg as weighed using a laboratory weighing balance was fed per time into the extrusion chamber. Five moisture levels of the moisture contents of the different formulated feeds were maintained all through the extrusion process at different stages of the extrusions for 16, 20, 24, 28 and 32% respectively.

The parameters of extruded feed of different die sizes (3 and 4.5 mm respectively) that were assessed were the moisture content and floatability following (Solomon et al., 2011; Olatunde, 2015) procedures.

Determination of moisture content

The moisture contents were measured by recording the weight of the extrudates before and after sun drying. The extrudates were dried to moisture content level of 10-12 %. The moisture content was obtained on wet basis which was given as:

$$\text{Moisture Content } (W_B) = \frac{W_i - W_f}{W_i} \times 100 \qquad (1)$$

where,

w_i is the initial weight of the extruded feed

w_f is the final weight of the extruded feed.

W_B is the wet basis.

Determination of floatability

Floatability tests for the feeds were performed using a glass measuring cylinder filled to the 250ml mark with borehole water. Triplicate samples of each extruded feed were placed in the measuring cylinder. The time taken for the feeds to remain afloat on water was noted using stopwatch. These were carried out following the method adopted by Solomon *et al.,* 2011 using transparent conical plastics for each treatment. At the end of every observation, the number of balls that floated was recorded accordingly following:

$$\%\ \text{ball afloat} = \frac{Fba}{Tb} \times 100 \qquad (2)$$

where,

F_{ba} is the final number of balls afloat.

T_b is the total number of balls.

This was repeated for feeds produced at the other moisture contents.

Plate 2: The floatability test

RESULTS AND DISCUSSION

Figures 2 a and b, 3 a and b, 4 a and b, 5 a and b, 6 a and b show the effect of formulation and die size on floatability at different moisture contents.

Effect of formulation and die size on floatability

At 16, 20 and 24% M.C, from Figures 2a, 3a and 4a, it was observed that the floatability of the feed for formulation 2 produced using 3 mm die were

70, 50 and 60% respectively when compared to the floatability of feed in Figures 2b, 3b and 4b using 4.5 mm die which were 60, 30 and 30% respectively also for the same formulation. But at 28% M.C from Figure 5a, it was observed that the floatability of the feed for formulation 3 produced using 3 mm die was 70% compared to the floatability of feed in Figure 5b using 4.5 mm die which was 30% for formulation 2. Also, at 32% M.C from Figure 6a, it was observed that the floatability of the feed for formulation 2 using 3mm die was 60% compared to the floatability of feed for formulation 2 produced using 3 mm die was 60% compared to the floatability of feed in Figure 6b using 4.5 mm die which was 70%.

Comparing the floatability of extrudates produced using 3 mm and 4.5 mm die from Figures 2a and 2b to 6a and 6b, it was observed that feeds from formulation 2 had the highest overall floatability followed by the feeds from formulation 3 for both dies. Formulations 2 and 3 had the highest level of floatability and this could be explained by the high proportion of soy bean meal, groundnut cake, yellow maize and starch which is in line with Saalah (2010) as cited by Solomon et al., (2010) where they reported the effect of formulation variation in the proportion of fish feed extrusion. They observed that floating significantly increased as the composition of soy bean meal, groundnut cake, yellow maize and starch increased and also concluded that floating ability was mainly influenced by these compositions.

CONCLUSIONS AND RECOMMENDATIONS

An existing single screw fish feed extruder was modified and was used to analyze the effect of formulation and die size on floatability at different moisture contents (16, 20, 24, 28 and 32%). Before extrusion, feeds were compounded, formulated and extruded while the moisture contents of the extrudates were determined. The characterizations of the extruded feed were assessed by measuring the following parameters; the moisture content and floatability. Comparing the floatability of extrudates produced using 3 mm and 4.5 mm die from Figures 2a and 2b to 6a and 6b, it was observed that feeds from formulation 2 had the highest overall floatability followed by the feeds from formulation 3 for both dies. Formulations 2 and 3 had the highest level of floatability. Conclusively, from the research work, formulations 2 and 3 had the highest level of floatability using 3mm die at 16% and 28% M.C.

Based on the experiments carried out on the floatability of feeds of different formulations at different moisture contents, the following recommendations were made:

i. The feeds from formulation 2 had the highest overall floatability at 16% M.C and can be used to feed fishes in large quantities.
ii. More experiments can be done on the extruder by lowering the moisture contents below 16% M.C while still retaining its nutritive value.

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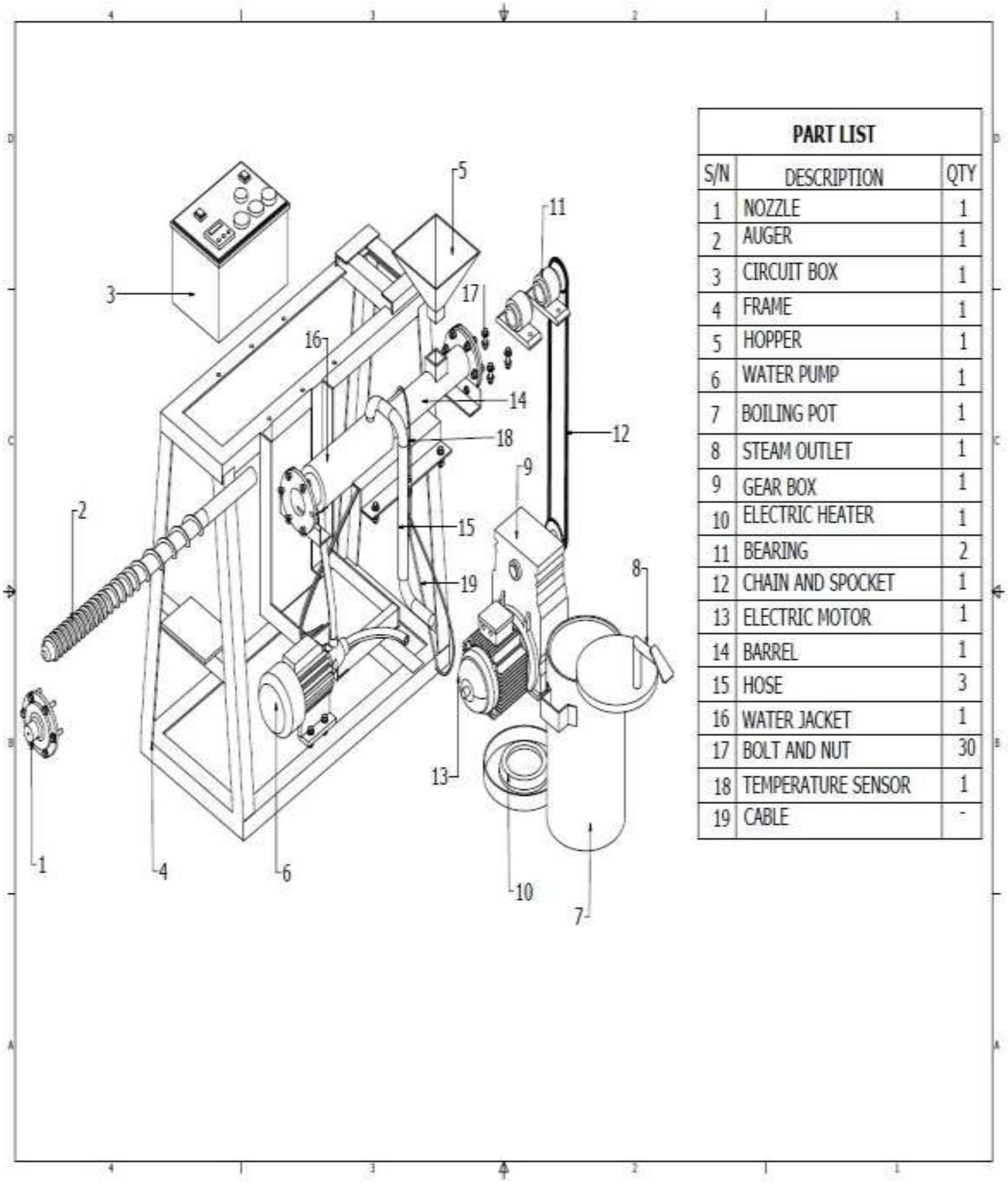


PART LIST

S/N	DESCRIPTION	QTY
1	NOZZLE	1
2	AUGER	1
3	CIRCUIT BOX	1
4	FRAME	1
5	HOPPER	1
6	WATER PUMP	1
7	BOILING POT	1
8	STEAM OUTLET	1
9	GEAR BOX	1
10	ELECTRIC HEATER	1
11	BEARING	2
12	CHAIN AND SPOCKET	1
13	ELECTRIC MOTOR	1
14	BARREL	1
15	HOSE	3
16	WATER JACKET	1
17	BOLT AND NUT	30
18	TEMPERATURE SENSOR	1
19	CABLE	-

Figure 1. Exploded view of the modified fish feed extruder

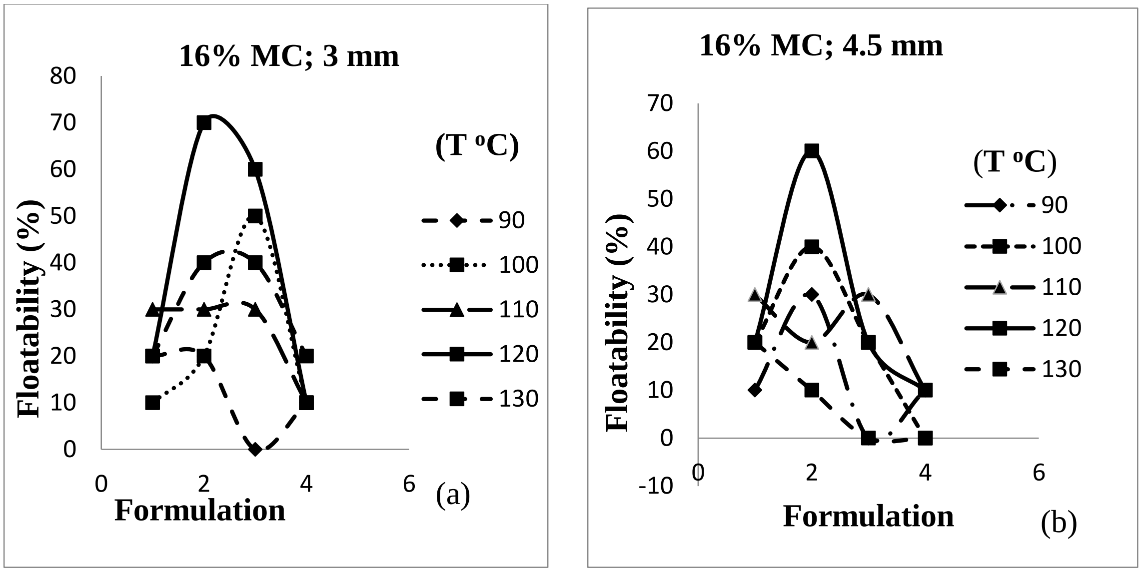


Figure 2 a and b. Effect of formulation on floatability of feeds produced at 16% MC using 3 and 4.5 mm die

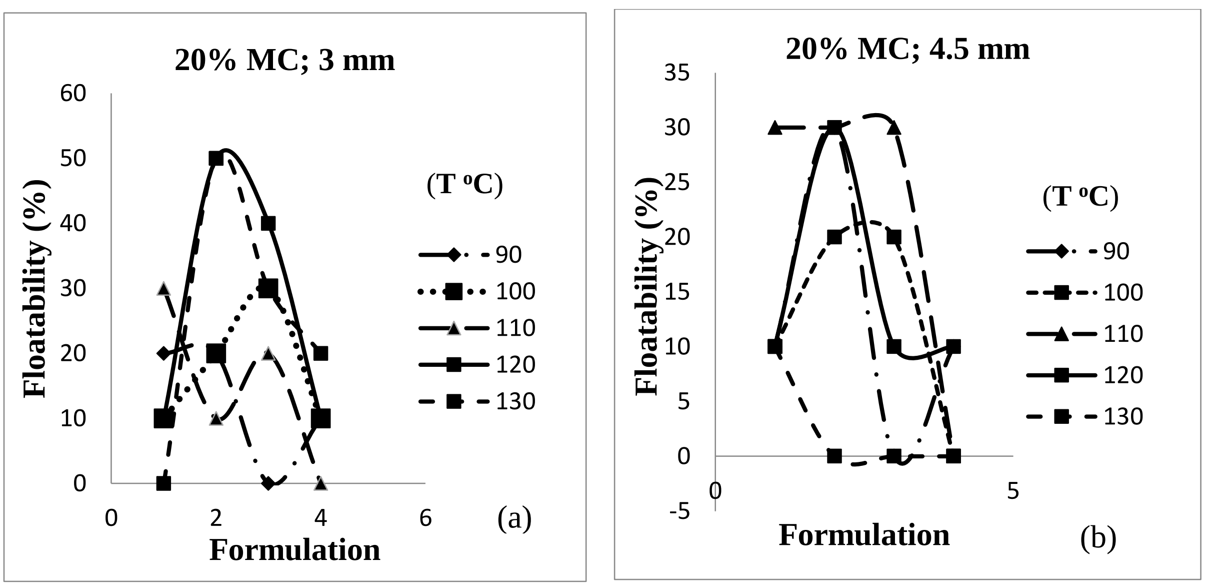
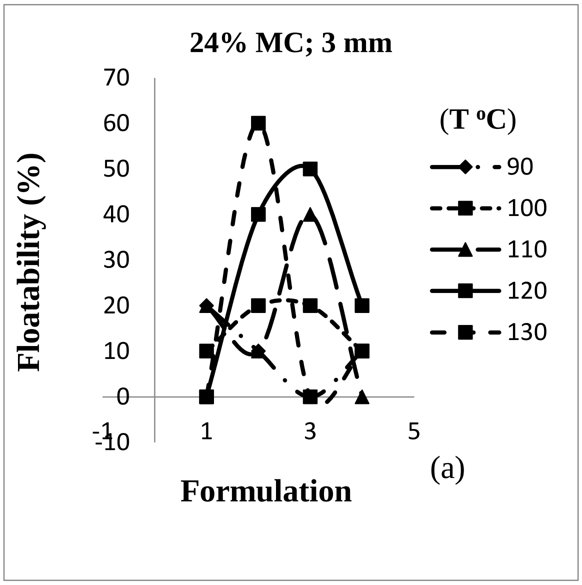


Figure 3 a and b. Effect of formulation on floatability of feeds produced at 20% MC using 3 and 4.5 mm die



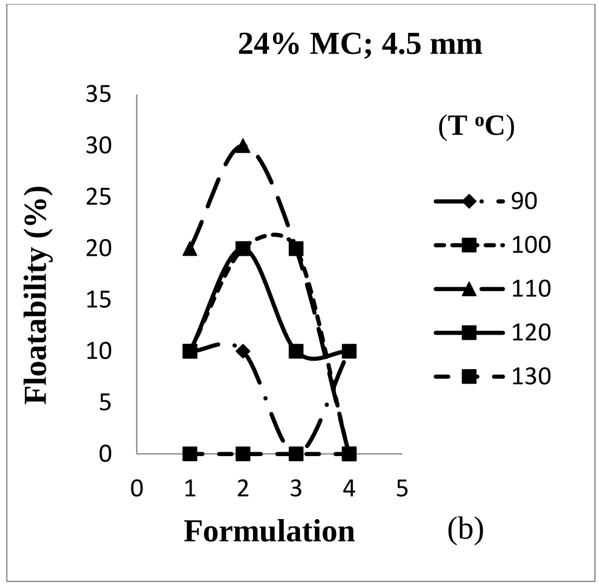
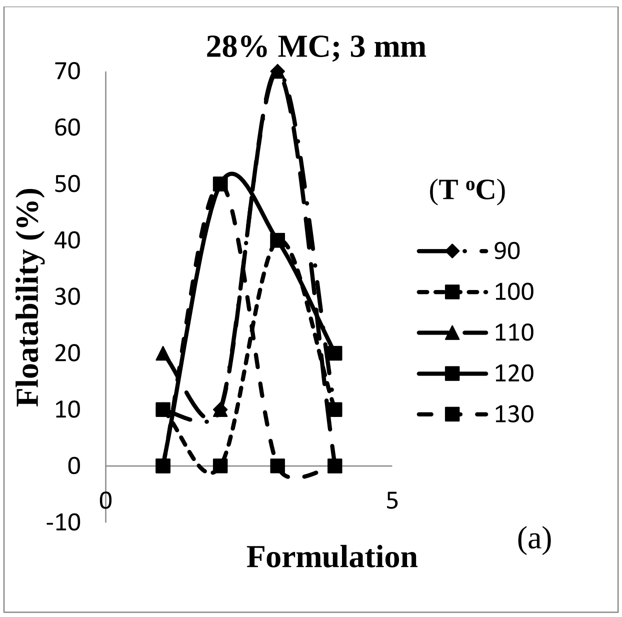


Figure 4 a and b. Effect of formulation on floatability of feeds produced at 24% MC using 3 and 4.5mm die



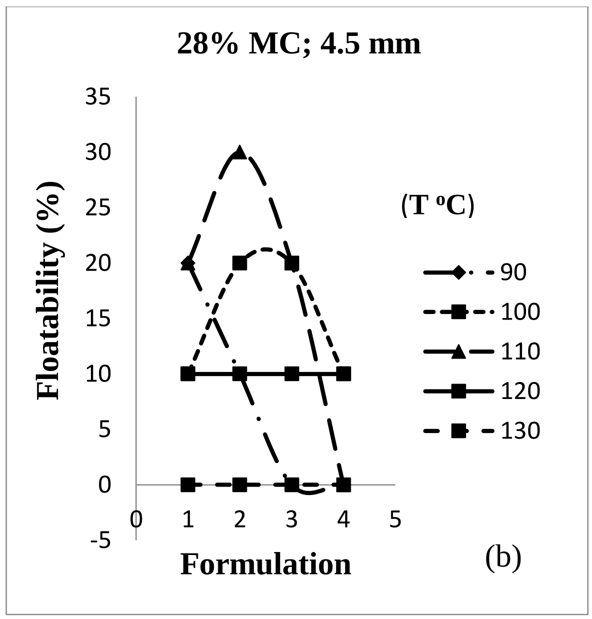


Figure 5 a and b. Effect of formulation on floatability of feeds produced at 28% MC using 3 and 4.5mm die

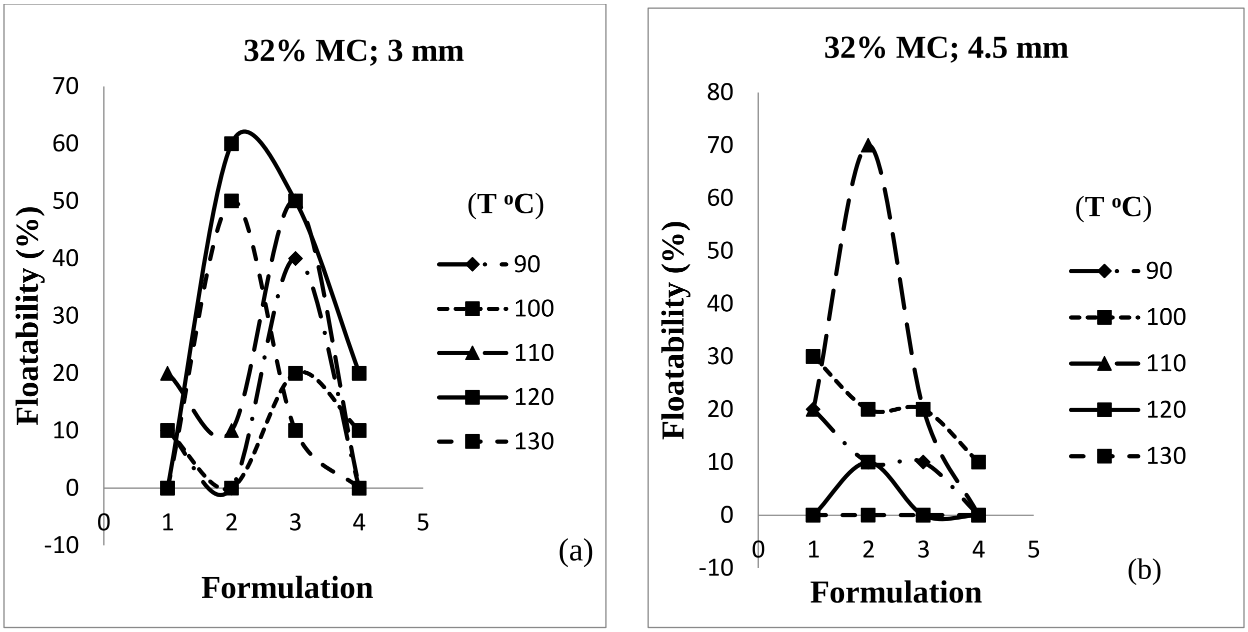


Figure 6 a and b. Effect of formulation on floatability of feeds produced at 32% MC using 3 and 4.5mm die