

# **Dietary effects of almond (*Prunus amygdalus dulcis*) seed powder on the reproductive indices in male African catfish (*Clarias gariepinus*) broodstock**

## **Abstract**

**Aims:** To examine the dietary effects of *Prunus amygdalus dulcis* seed meal on the sperm quality of male African Catfish (*Clarias gariepinus*).

**Place and Duration of Study:** The experiment was carried out at the Department of Fisheries and Aquaculture Technology Teaching and Research Farm, The Federal University of Technology, Akure for a period of 70days.

**Methodology:** Five diets with crude protein of 40% were formulated with different inclusion levels of *P. amygdalus dulcis* seed powder. D1 (control) has 0 g of the powder, while D2, D3, D4 and D5 has 5, 10, 15 and 20g of the *P. amygdalus dulcis* seed powder respectively. A total of 45 *C. gariepinus* were randomly distributed into 15 concrete tanks (2×2×1.5m) at stocking density of 3 fish per tank and constant water level of 1m was maintained in the experimental tanks. The fish were fed at 3% of body weight twice a day between 08.00-09.00 and 16.00-17.00 hours for a period of 70 days. At the end of the 70-day experiment, gonadosomatic index and reproductive indices such as milt volume, motility duration, spermatozoa count, percentage motility, percentage fertilization, percentage hatchability and percentage survival of fry were determined. The qualities of the milt were assessed by aid of microscope and by fertility tests. Histological examination of the testes of fish fed each of the diets was also carried out.

**Results:** Fish fed experimental diets showed significantly improved gonado-somatic index and reproductive indices over the control treatment. Higher gonado-somatic index and reproductive indices were recorded for the fish fed diet of 20g/kg *P. amygdalus dulcis* seed powder compared to other experimental diets.

**Conclusion:** The results indicated that supplementing diets with *P. amygdalus dulcis* seed powder enhanced growth and improved gonadosomatic index, and reproductive indices of male *C. gariepinus* broodstocks which can be exploited in fish seeds production

**Keywords:** *Prunus amygdalus dulcis*, Sperm quality, Fertility, gonado-somatic index

## **Introduction**

Over the years, the demand for fish and fish products all over the world is very high compared to the quantity supplied. Decrease in supplies from ocean fisheries as a result of over-exploitation of fish resources, habitat destruction and pollution has led to increased aquaculture activities which in turn increased food production (Adedeji and Okocha, 2011).

The major fish species cultured in Nigeria include tilapia, catfish and carp. However, the African catfish (*Clarias gariepinus*) is the most widely cultured in Nigeria. It is appreciated by consumers for the quality of its meat (Pruszyński, 2003). The African catfish is an excellent species for aquaculture as it is omnivorous, grows fast and tolerates relatively poor water quality (Rad *et al.*, 2003). However, there are limitations associated with fry production and the development of better broodstock management techniques which is important for improvement of fry yield. The ever-growing demand for the seed of African catfish *C. gariepinus* calls for more production of high-quality milt which could be used to fertilize the eggs in the hatchery (Dada and Fagbohun, 2018). Hence, the increase in research into various

41 ways of improving the reproductive ability of fish in order to meet the growing demands for fish and fish  
42 product.

43 Medicinal plants have been known to be of great benefit to animals including man. The leaves, roots and  
44 seeds of medicinal plants contain phytochemicals and antioxidants which have the tendency to increase  
45 sperm count, motility, and enhance sperm morphology (Javeed *et al.*, 2011; Ramandeep *et al.*, 2013).  
46 Although the toxicity profile level of most medicinal plants has not been evaluated, it is generally  
47 accepted that medicine derived from plants are safer than synthetic medicines (Oluyemi *et al.*, 2007).  
48 Previous studies revealed that the use of medicinal plants in fish feed affects the milt quality and  
49 reproductive indices of the male African catfish *Clarias gariepinus* with little or no adverse effect on the  
50 fish (Dada and Ogunduyile, 2011; Dada and Adeparusi, 2012; Dada and Aguda, 2015; Dada and Ajilore,  
51 2009; Dada, 2013; Francis *et al.*, 2013).

52 *Prunus amygdalus dulcis* commonly called almonds are a good source of nutrients which are associated  
53 with the health of the heart, such as vitamin E, mono unsaturated fatty acids, poly-unsaturated fatty acids  
54 (PUFA), arginine, and potassium (USDA, 2004). Almond seeds are great sources of vitamin E, calcium,  
55 magnesium and potassium, all important for testosterone production (USDA, 2009). Male sexual behavior  
56 and reproductive performance depends on the circulating levels of testosterone in the blood (Mitra *et al.*,  
57 1996).

58 Almonds are also rich in arginine, a substance that can also increase male libido. They also contain  
59 antioxidants such as vitamin E, phenols, steroids and flavonoids (USDA, 2009; Kornsteiner *et al.*, 2006;  
60 Milbury *et al.*, 2006). Almond has various therapeutic use and aphrodisiac effects in mammals. However,  
61 there is paucity of information its effects on sexual behavior, growth and reproductive indices of fish.  
62 This study was therefore carried out to evaluate the efficacy of *Prunus amygdalus dulcis* seed meal on the  
63 reproductive indices in male African catfish (*Clarias gariepinus*) broodstock.

## 64 **Materials and methods**

### 65 **Experimental site**

66 The experiment was carried out at the Department of Fisheries and Aquaculture Technology Teaching  
67 and Research Farm, The Federal University of Technology, Akure.

### 68 **Collection and acclimation of experimental fish**

69 Experimental broodstock of average weight ( $491 \pm 7.04\text{g}$ ) were sourced from a reputable fish farm in  
70 Akure. The broodstock were conditioned for two weeks in concrete holding tanks at the Department of  
71 Fisheries and Aquaculture Technology Teaching and Research Farm, Federal University of Technology,  
72 Akure. During this period, they were fed with commercial diets of 40% crude protein twice daily at 3 %  
73 of their body weight.

### 74 **Formulation of experimental diets**

75 *Prunus amygdalus dulcis* was purchased from a local market in Akure, Ondo State, Nigeria. The seeds  
76 were air-dried for three days between 09:00-17:00 hours after which it was ground to fine powder.  
77 Amounts of 0 (control), 0.5, 1.0, 1.5 and 2.0 g *Prunus amygdalus dulcis* seed meal was measured and  
78 added per 100g basal feed of 40% crude protein. The basal feed contained fish meal, soybean meal, corn  
79 meal, cod liver oil, vegetable oil and vitamin/ mineral premix. All ingredients were milled into small  
80 particle size and weighed with a sensitive weighing balance (Metler Toledo PB 8001 London). The  
81 ingredients were thoroughly mixed in a Hobart A- 2007 pelleting and mixing machine (Hobart Ltd,  
82 London, UK) to obtain a homogenous mass and corn starch was added as a binder. The resultant mash  
83 was then pressed without steam through a mixer with 0.9 mm diameter size. The pellets were dried at  
84 ambient temperature (27 – 30°C) and stored at -20°C in a refrigerator until the start of the experiment.

85 The diets were analyzed for proximate composition (moisture, crude fat, crude fibre, ash, crude protein  
 86 and nitrogen free extract) according to the standard procedures as described by Association of Official  
 87 Analytical Chemists (AOAC, 2005).

88 **Table 1:** Ingredient composition (grams per 100 grams feed)

Ingredients	Experiments				
	D1	D2	D3	D4	D5
Fishmeal (65% CP)	25	25	25	25	25
Soybean (45% CP)	40	40	40	40	40
Corn meal (10% CP)	15	15	15	15	15
Blood meal (80% CP)	5	5	5	5	5
Fish oil	4	4	4	4	4
Vegetable Oil	6	6	6	6	6
Mineral-vitamin premix	3	3	3	3	3
Binder	2	2	2	2	2
<i>P. amygdalus dulcis</i> seed powder	0	0.5	1.0	1.5	2.0
<b>Proximate composition (% dry matter)</b>					
Moisture	10.05	10.95	10.70	10.50	10.05
Crude fat	17.00	18.00	18.00	19.00	19.00
Crude protein	40.33	41.12	41.10	40.90	41.16
Crude fibre	3.17	2.92	3.26	3.38	3.36
Ash	14.10	14.15	11.75	14.15	15.75
NFE	15.35	12.86	15.19	12.07	10.68

89 Mineral-vitamin premix- An Animal Care Optimix Aqua product for catfish, containing the following per  
 90 5kg of premix: A = 20,000,000 I.U, D3 – 2,000,000 I.U, E – 200,000 mg, K3 = 10,000 mg, B2 = 12,000  
 91 mg, B12 = 9mg, B1 = 6,000 mg, B6 = 11,000 mg, C = 50,000 mg, folic acid = 2,000 mg, Niacin = 80,000  
 92 mg, Calpan = 25,000 mg, Biotin = 100 mg, x Zinc = 30,000 mg, Copper = 5,000 mg, Iron = 30,000 mg,  
 93 Manganese = 50,000 mg, Iodine = 1,000 mg, Selenium = 100 mg, antioxidant = 125,000 mg.

94 NFE- Nitrogen free extract

95 **Experimental set-up**

96 Forty-five *Clarias gariepinus* broodstock were stocked into 15 concrete tanks (2 × 2 × 1.5m) at a density  
 97 of 3 (three) fish per tank with three replicates per treatment. The diets were manually fed to the  
 98 broodstock at a daily rate of 3% body weight (BW), twice a day (08:00-09:00 and 16:00- 17:00hours) for  
 99 70days. Fish were weighed collectively bi-weekly. Their average weights were recorded and the daily  
 100 amount of feed for each tank was readjusted accordingly.

## 102 **Evaluation of milt quality**

103 At the end of the feeding trial, 3 male fish were randomly selected from each dietary treatment and the  
104 testes were removed to determine milt quality indices (milt volume, motility duration, percentage motility  
105 and spermatozoa concentration). To determine the milt volume, small incision was made into the lobes of  
106 the testes and the milt squeezed out into a Petri dish. This was then measured with plastic syringe in ml.  
107 The motility duration was determined by placing 1µl of milt from each male on a Neubauer  
108 hemocytometer. A drop of distilled water was then added and it was covered with a slip. The sperm  
109 activity was viewed under Olympus microscopic at 100 x magnification to see when all the sperm stop  
110 (Mims, 1991). Percentage motility was estimated using light microscope at 400x magnification  
111 immediately after addition of 20 µl distilled water as an activating solution. During spermatozoa  
112 activation, immotile sperm cells (ISC) were counted. When the activation stopped, whole sperm cells  
113 (WSC) were counted (Canyurt and Akhan, 2008). The motile sperm cells (MC) will be calculated as

$$114 \quad MC = WSC - ISC$$

$$115 \quad \%MC = \frac{MC}{WSC} \times 100$$

116 Where, MC = Motile sperm cells

117 WSC= Whole sperm cells

118 ISC= Immotile sperm cells

119 Concentration of sperm was determined by counting the number of spermatozoa in sample dilute with  
120 distilled water (100 x) in a Burker haemocytometer, under 400x magnification (Rainis *et al.*, 2003).

## 121 **Fertility test**

122 One Female broodstock (1.5kg) was purchased from a reputable farm in Akure, Ondo-State. It was  
123 injected with 0.5ml/kg Ovaprim and left for 12 hours which is the latency period before stripping. Fifteen  
124 males were randomly selected from the treatments (3 per treatment) to remove the sperm sac of the fish.  
125 This was done by dissecting the fish in order to remove the sperm sac. The female was stripped of its egg  
126 in a clean bowl (2 litres) after which 1g of the egg was measured into fifteen different bowls which were  
127 labeled according to the treatment. The eggs were fertilized with the milt from each dietary treatment.

## 128 **Determination of fertilization, hatchability and gonado-somatic index**

129 The number of fertilized and unfertilized eggs were counted and used to make the following calculations:

$$130 \quad \% \text{ Fertilisation} = \frac{\text{number of fertilised eggs}}{\text{total number of eggs counted}} \times 100$$

$$131 \quad \% \text{ Hatchability} = \frac{\text{number of eggs hatched}}{\text{total number of eggs in batches}} \times 100$$

$$132 \quad \% \text{ Survival} = \frac{\text{number of hatchlings alive up to larval stage}}{\text{total number of hatchling}} \times 100$$

133 The gonado-somatic index (GSI) was computed according to King (1995) as

$$134 \quad \frac{\text{weight of gonad}}{\text{weight of fish}} \times 100$$

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138 **Histological examination of testes**

139 At the end of 70 days feeding trials, two males were randomly collected from tanks containing each  
140 treatment. The fish were killed by decapitation and the gonads were removed for sectioning and  
141 histological examination according to the procedure described by Krause (2001)

142 **Statistical analysis**

143 Data were evaluated using analysis of variance (ANOVA) using the statistical package for social  
144 scientists- SPSS 22 software at significance level of 95%. The variance of significance was verified using  
145 Duncan test.

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147 **Results**

148 Results of varying inclusion levels of *P. amygdalus dulcis* seed powder on the reproductive performance  
149 of male African catfish is presented in Table 2. The greatest effect of *P. amygdalus dulcis* seed powder on  
150 reproductive parameters was measured on the duration of sperm motility. The duration of sperm motility  
151 of fish fed *P. amygdalus dulcis* seed powder at any level was greater than that of fish fed the control diet.  
152 There was no significant difference ( $p > 0.05$ ) in the milt volume of the experimental fish. However, the  
153 highest milt volume was recorded in fish fed diet D4 while the lowest was recorded in fish fed diet D2.  
154 There was significant difference ( $P < 0.05$ ) in the weight of testes with fish fed diet D4 having the highest  
155 value while fish fed on control diet D1 had the lowest value. This reflects in the corresponding increase in  
156 milt volume. Similarly, there was significant difference ( $P < 0.05$ ) in gonado-somatic index and milt  
157 motility and this reflects in greater improvement in the motility duration of fish fed with diets  
158 supplemented with varying inclusion levels of *P. amygdalus dulcis* seed powder when compared with the  
159 control. However, there were significant differences ( $p < 0.05$ ) in spermatozoa concentration across the  
160 fish fed different diets supplemented with *P. amygdalus dulcis* seed powder. Egg fertilization, hatchability  
161 and survival were significantly greater in treatments with dietary *P. amygdalus dulcis* seed powder as  
162 compared to the control. Mean water quality parameters during the experiment were temperature  
163  $27.42 \pm 0.45$ , dissolved oxygen  $7.09 \pm 0.48$  mg/l and pH  $7.39 \pm 0.22$ .

164 The results of the histology of the transverse sections of the testes of *C. gariepinus* of the control fish and  
165 fish fed dietary *P. amygdalus dulcis* revealed reduced seminiferous tubular lumen and scanty spermatozoa  
166 in the control fish and D2 (fish fed with 5 g/kg feed *P. amygdalus dulcis*). The seminiferous lumen  
167 became densely filled with ripe spermatozoa in the fish fed D3, D4 and D5 respectively. However, there  
168 were no visible lesions seen or alterations in the cell structure. The results are presented in figure 1  
169 respectively.

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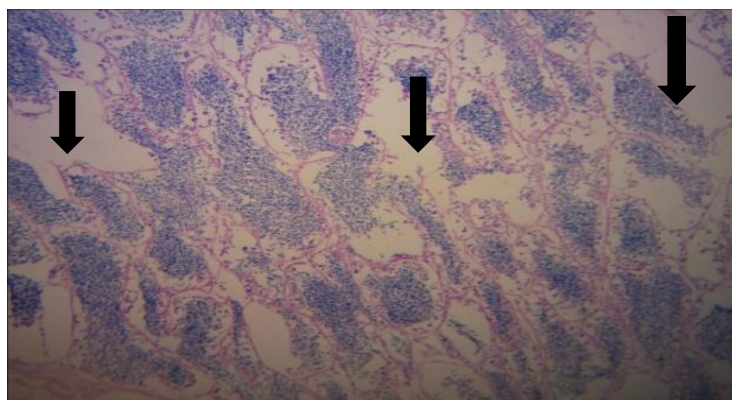
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184 **Table 2:** Mean growth performance and reproductive performance of *C. gariepinus* broodstock fed for 70 days.

Parameters	Dietary treatments				
	D1	D2	D3	D4	D5
Initial average weight (g)	451.61±5.55 <sup>c</sup>	489.82±2.61 <sup>b</sup>	519.52±5.01 <sup>a</sup>	517.01±4.99 <sup>a</sup>	477.03±5.21 <sup>b</sup>
Final average weight (g)	638.98±8.96 <sup>b</sup>	686.72±8.04 <sup>a</sup>	640.45±3.88 <sup>b</sup>	652.52±18.69 <sup>ab</sup>	659.94±9.62 <sup>ab</sup>
Weight gain (g)	187.37±5.62 <sup>a</sup>	196.90±10.62 <sup>a</sup>	120.93±7.30 <sup>b</sup>	135.51±14.09 <sup>b</sup>	182.91±6.60 <sup>a</sup>
Milt volume (ml)	0.5±0.40 <sup>b</sup>	0.35±0.05 <sup>c</sup>	0.75±0.35 <sup>b</sup>	1.90±0.70 <sup>a</sup>	1.60±0.30 <sup>a</sup>
Motility duration (mins)	2.08±1.10 <sup>a</sup>	1.63±0.18 <sup>a</sup>	1.67±0.62 <sup>a</sup>	2.94±0.89 <sup>a</sup>	3.87±0.42 <sup>a</sup>
Spermatozoa concentration (×10 <sup>9</sup> spm/ml)	1.49±0.32 <sup>bc</sup>	1.36±0.06 <sup>c</sup>	1.65±0.18 <sup>b</sup>	1.67±0.35 <sup>b</sup>	2.10±0.14 <sup>a</sup>
Motility (%)	56.22±16.34 <sup>ab</sup>	50.85±1.31 <sup>b</sup>	62.02±9.06 <sup>ab</sup>	70.39±11.71 <sup>ab</sup>	90.46±3.29 <sup>a</sup>
Fertilization (%)	91.07±3.32 <sup>b</sup>	97.43±0.55 <sup>a</sup>	97.73±0.12 <sup>a</sup>	97.47±0.32 <sup>a</sup>	97.43±0.22 <sup>a</sup>
Hatchability (%)	64.00±2.51 <sup>c</sup>	66.37±2.39 <sup>bc</sup>	74.50±3.78 <sup>ab</sup>	75.37±1.43 <sup>a</sup>	78.20±2.38 <sup>ab</sup>
Survival (%)	80.29±5.21 <sup>b</sup>	84.94±2.34 <sup>ab</sup>	86.27±2.20 <sup>ab</sup>	90.28±1.66 <sup>a</sup>	94.16±1.46 <sup>a</sup>
Weight of testes (g)	2.13±0.84 <sup>c</sup>	3.30±0.21 <sup>bc</sup>	5.43±1.71 <sup>abc</sup>	8.10±1.49 <sup>a</sup>	6.97±1.79 <sup>ab</sup>
GSI	0.34±0.13 <sup>c</sup>	0.51±0.05 <sup>bc</sup>	0.75±0.18 <sup>ab</sup>	1.15±0.21 <sup>a</sup>	0.95±0.20 <sup>ab</sup>

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186 Mean in each row having the same superscript are not significantly different (p>0.05)  
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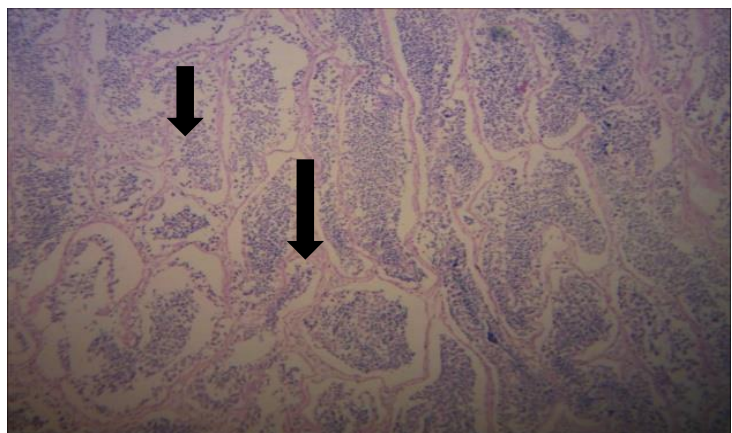
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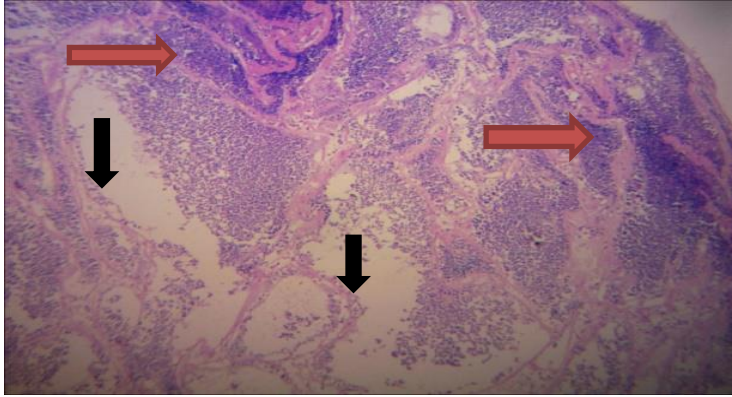


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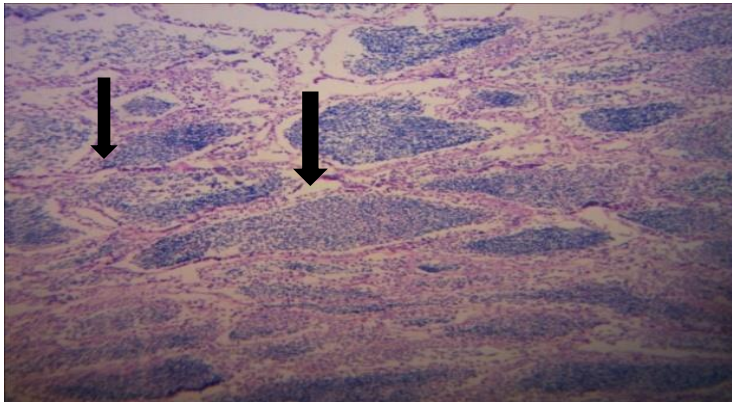
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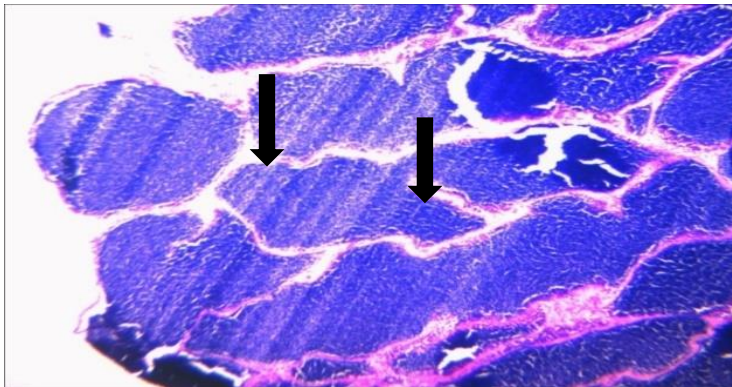
194 (C)  
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Figure 1: Effects of dietary supplementation of almond seed powder on the histology of the testes of *C. gariepinus*. (A) A transverse section through the testes of *C. gariepinus* fed D1 (Control) (0 mg/kg feed of *P. amygdalus dulcis*), arrows showing many seminiferous tubular sections that are scanty and devoid of spermatozoa. There are no visible

214 lesions seen. Magnification  $\times 100$ . (B) A transverse section through the testes of *C. gariepinus* fed diet D2 (5g/kg  
215 feed of *P. amygdalus dulcis*), arrows showing a few seminiferous sections that have scanty spermatozoa. There are  
216 no visible lesions seen. Magnification  $\times 100$ . (C) A transverse section through the testes of *C. gariepinus* fed diet  
217 D3 (10g/kg feed of *P. amygdalus dulcis*), black arrows showing some seminiferous sections that are not fully  
218 distended with spermatozoa while red arrows are showing area fully distended with spermatozoa. There are no  
219 visible lesions seen. Magnification  $\times 100$ . (D) A transverse section through the testes of *C. gariepinus* fed diet D4  
220 (15g/kg feed of *P. amygdalus dulcis*), arrows showing organized lobules with no visible lesions but the  
221 spermatocytes are not optimally full within the seminiferous lumen. Magnification  $\times 100$ . (E) A transverse section  
222 through the testes of *C. gariepinus* fed diet D5 (20g/kg feed of *P. amygdalus dulcis*), arrows showing densely filled  
223 lumen and a well differentiated seminiferous tubule with ripe spermatozoa ready to be released through the sperm  
224 duct. Magnification  $\times 100$ .

## 225 Discussion

226 The present study confirmed that dietary supplementation of *P. amygdalus dulcis* seed powder at all  
227 inclusion level improved the reproductive indices and GSI of cultured male African catfish, *C.*  
228 *gariepinus*. Normal feed intake was observed for the experimental fish. Dietary inclusion of *P. amygdalus*  
229 *dulcis* affected positively some parameters of sperm quality in *C. gariepinus*, such as spermatozoa  
230 concentration, percentage motility, milt volume and motility duration. The inclusion resulted in weight  
231 gain of fish fed diet D2 when compared with control. However, fish fed diets D2 to D5 showed increase  
232 in weight of testes when compared with control. These showed that *P. amygdalus dulcis* seed meal may  
233 have enhanced nutrient utilization which is reflected by improvement in weight of testes. Spermatozoa  
234 concentration was highest in fish fed with diet D5 when compared with fish fed other diets. Spermatozoa  
235 concentration increased with increasing inclusion levels of *P. amygdalus dulcis* seed meal. The increase  
236 in the spermatozoa concentration of *C. gariepinus* obtained in these studies could be as a result of the  
237 presence of vitamin E (tocopherol) a known fertility agent in the seed. This compound is potent  
238 antioxidant which is capable of playing a major role in scavenging free radicals that might accumulate to  
239 reduce the number of sperm cells thereby leading to an increase in the sperm counts (Keskes-Ammar *et*  
240 *al.*, 2003).

241 Another factor which could be the cause for improvement in the reproductive indices in this study is the  
242 increase in testosterone and follicle stimulating hormone. Testosterone and FSH are reported to be  
243 responsible for spermatocytogenesis and spermatogenesis in the seminiferous tubules. Umeda *et al.*,  
244 (1982) reported that vitamin E increased testosterone level in male rats and human subjects. Testosterone  
245 alone is responsible for maturation of spermatozoa (McLachlan *et al.*, 2002). This can be seen in the  
246 results from the histological examination of the testes of fish fed diets. It was observed that fish fed on 20  
247 g/kg dietary inclusion of *P. amygdalus dulcis* had higher concentration of matured spermatozoa when  
248 compared with fish fed other diets. The presence of magnesium, zinc folate and vitamin B6 in *P.*  
249 *amygdalus dulcis* stimulates the hypothalamus to increase testosterone (Hoffman *et al.*, 2011; Jalali *et al.*,  
250 2010; Cinar *et al.*, 2011; Wallock *et al.*, 2007). Gopumadhavan *et al.*, (2003) in their study with a  
251 polyherbal formulation (Tentex Royal) which contained *Prunus amygdalus* along with other herbal  
252 preparations, showed a significant improvement in all the parameters of the sexual indices such as total  
253 sexual behavior, mounting frequency, ejaculation frequency, ejaculation latency, serum testosterone  
254 levels and sperm count.

255 At present, there are no truly dependable criteria for estimating sperm quality. In human, mammals and  
256 fish, the length of time and intensity of spermatozoa motility, the percentage motile sperm and sperm  
257 density are all parameters that have been measured in an attempt to assess sperm quality (Billard and  
258 Cosson 1992). Moreover, fertilizing capacity is the most conclusive way of testing sperm quality (Billard  
259 *et al.*, 1995). Spermatozoa motility is the most commonly used criterion to evaluate semen quality  
260 (Bozkurt *et al.*, 2006), however spermatozoa motility varies in rigor and duration not only among male  
261 but also within an individual male depending on the ripeness, age and time of sampling. It was observed



262 that fish fed on 20 g/kg dietary inclusion of *P. amygdalus dulcis* showed the highest motility of 90.46%  
263 when compared with fish fed the other diets. Investigation revealed that teleosts spermatozoa must swim  
264 actively into the micropylar channel for successful fertilization (Iwamatsu *et al.*, 1993).  
265 Adeparusi *et al.* (2010) reported that *C. gariepinus* broodstock fed dietary *Kigelia africana* seed meal had  
266 higher sperm density, higher percentage hatching and larval survivals than the control fish. The results  
267 showed that *P. amygdalus dulcis* seed powder has significant impact on the milt quality of *C. gariepinus*.  
268 Percentage fertilization and hatchability increased with dietary inclusion levels of *P. amygdalus dulcis*  
269 seed powder. The results obtained from the photomicrographs of the transverse section through the testes  
270 of the fish fed on dietary seed powder showed that the *P. amygdalus dulcis* seed powder has positive  
271 effect on the histology of the testes. The testes of *C. gariepinus* fed on control diet had many seminiferous  
272 tubular sections that were scanty and devoid of spermatozoa. The histological transverse section of the  
273 fish fed dietary *P. amygdalus dulcis* seed powder showed marked effects of *P. amygdalus dulcis* on the  
274 testicular structure with the spermatozoa dispersed but more matured seminiferous lumen in fish fed diet  
275 D2, but apparently more in fish fed diet D3 which shows densely populated lumen of the lobule when  
276 compared with the control. Similar results were reported by Sharma *et al.* (2008) who used the aqueous  
277 extract of *Anacyclus pyrethrum* medical herb as a fertility enhancing agent for male rats. High milt count  
278 in seminiferous lumen, confirmed increased spermatogenesis observed in the testicular histology of fish  
279 fed diets D3, D4 and D5, which signified better spermatogenetic activity of *P. amygdalus dulcis*.  
280 Furthermore, the lumen of their seminiferous tubules showed evidences of hyper-spermatozoa formation  
281 in fish fed diets D4 and D5. The improvement in the testicular histology of fish fed on dietary *P.*  
282 *amygdalus dulcis* seed powder could be due to antioxidative properties of vitamin E present in the seed  
283 (USDA, 2016). Vitamin E protects the testis against lipid peroxidation, hence, promotes spermatogenesis  
284 and prevents testicular dysfunction and shrinkage of semeneferous tubules (Sulieman *et al.*, 1996). This  
285 vitamin also enhances the functions of testes in the form of increased in weight of testes and epididymis  
286 (Muhammad, 2017).

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### 290 **Conclusion**

291 In conclusion, dietary supplementation with *P. amygdalus dulcis* seed powder is a useful, effective and a  
292 reliable method for propagating seedling production and rearing strategy. This study established the  
293 potency of *P. amygdalus dulcis* seed powder as fertility enhancer in *C. gariepinus* brood stock and should  
294 be encouraged as it will minimize the dependence on synthetic drugs as fertility enhancing agents.  
295 The use of almond seed meal is recommended as a feed additive for improved reproductive performance  
296 of male African catfish broodstock. Future research should focus on the improvement of fry production  
297 technology for different fish species using almond seed meal, inasmuch as the main aim of aquaculture is  
298 to maximize fish production. This plant has promising pro-fertility properties that can be exploited in  
299 aquaculture.

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### 301 **References**

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