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MORPHOLOGY OF STRAINS PRODUCED AT PARTIAL DIALLEL CROSS OF GIFT TILAPIA AND UPM RED TILAPIA

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ABSTRACT

The traits that could be used to explain morphometric and meristic characteristics of F2 Hybrid, BC1F2, UPM red Tilapia and Gift Tilapia were examined using Principal Component Analysis in Unscramble@ X statistical tool. A total of 25 morphometric and 5 meristic observations were taking using the buss truss protocol. The score value, correlation loading and the bi-plot was used in explaining the discriminate value. The Score plot shows that the morphometric traits could be represented by the first 2 principal components (PC1 and PC2), with 85% of the original variance in the data set (PC1: 58% and PC2: 27%). Meristic observation used for the scores were the dorsal fin (DF), anal fin (AF), pelvic fin (PF) caudal fin and pectoral fin (Pe).They were represented in the first 2 principal components (PC1 and PC2) with original value of 82% (PC1: 44% and PC2: 38%). Recorded scores for the morphometric traits were used to explain the differences that exist `by the pure strain of UPM red tilapia, Gift tilapia and their hybrids. Although in the study the meristic traits could not be used for proper identification but could identify at the field level

Keywords: Gift tilapia, Hybridization, Loading, UPM Tilapia

INTRODUCTION

Tilapia, a fish regarded as weed in Malaysia in the 1950's grew to become the second most cultivated fish in the world. In recent times, the production capacity of 4.5 million tons of tilapia was achieved in 2012 (Fernandes et al., 2015; Department of Fisheries malaysia, 2013).

Generally tilapia is an important fish hence value is placed on need to improve breeding technique and efficient culture system. Likewise the need to produce strains based on consumer need and demand, traits like colour, fillet quantity (Fillet quantity tilapia is a bony fish hence a need to increase quantity of fillet) and general improve growth rate were evaluated for future improvement (Lago *et al*., 2016)

El-Sayed, (2019) reported that tilapia has the ability to adapt to varying water bodies of different salinity, disease resistance and temperature. Similarly Minghui and Deshou. (2017); Bentsen et al. (2017) and Lago et al. (2016) examine ways of improving various traits of Tilapia with the aim of producing fish that will have bigger acceptance rate by larger populace. Value place on Tilapia increase the rate at which studies on various improvement methods were carried out. The quest for producing Tilapia with improved growth, colour and fillets quality resulted in various hybridization and selection processes and collaborated programs that resulted in a fish called 'GIFT' the Genetically improved farm Tilapia, which is a product of World Fish center in collaboration with Tilapia producing countries (Khaw et al., 2016 and Ponzoni et al., 2011)

Most breeding program were with the aim of improving one traits or the other but this sometimes lead to un-control pairing and production of strain whose parent is not known. This new undocumented strains could eventually escaped to water bodies of the region. At the time the escaped fish reproduce with natural strains in the water body, the base population could be endangered (Deines, 2014)

The ability to identify pure breed is important for the Farmer and the Researcher that might require the use of pure breed for specific program. Nwachi and Esa (2016) reported incidence of combination of strains to produce certain percentage of males in Tilapia not breeding true because of the inability of the culturist to properly identify pure breed of species that follow this principle .

The UPM red Tilapia is an endemic strain that was developed in the Aquaculture Center of the Universiti Putra Malaysia by the mating of *Oreochromis niloticus (Linnaeus, 1758)* and *Oreochromis* *mossambicus (Peters, 1852).* The red colouration of this fish makes it unique and attractive. The proliferation of red Tilapia in Malaysia made it almost impossible to identify strains of red Tilapia and even Tilapia in general based on the expressed morphometric characteristics hence this work was carried out to find traits (Morphometric and Meristic) that could be used to identify strain.

MATERIALS AND METHODS.

This work was carried out at the Makmal Abuatak Aquaculture center of Universiti Putra Malaysia (Latitude 2.9917^0 N, Longitude 101.7163). Mixed sex samples of Gift Tilapia (n=25) were obtained from a standing crop maintained at the World Fish Center Penang Malaysia. The UPM Red Tilapia is a strain that was developed in the Universiti over a decade ago. Samples were taken from the available stock (n=25). The F_2 hybrid was obtained by crossing the F_1 from the cross between Gift Tilapia and UPM red Tilapia, the Bc_1F_1 was obtained from the crossing of BcF with the F_1in Table 1,while the genetically improved farm Tilapia was obtained from a stock gotten from the World Fish Center Penang and maintained at aquaculture center . To produce the test fish gravid parents of age 6 – 9 months were selected and paired at a ratio (1:3) for the male and female fish in a 1 m^2 hapa. These were placed in a 100 x 4.5 x 100 meter man- made lake. They were fed to satiation with commercial feed based on their weight; fries and egg were collected from the hapa after 16 – 18 days of culturing, for stocking (fries) and or continues hatching (eggs). A total of 25 each of F_2 and $Bc1F_1$ were selected from the production tank after 5 months of rearing

Table 1: Diallele cross between Gift tilapia and UPM red tilapia

Parent 1	Parent 2	Hybrid
Gift tilapia	UPM red tilapia	F_1
F_1	F_1	F_2
UPM red tilapia x Gift tilapia (BcF)	F_1	Bc_1F_1

The test fish were transferred to the wet laboratory and kept in a glass flow through aquaria that were filled with 150 L of dechlorinated stock water. The measurements were carried out at a temperature of 30.5-33.5^{0}C.

A total of twenty body distances were measured by same person to avoid using the buss truss protocol (Strauss and Bookstein, 1982). The measurements taken include: Total length (TL) distance between the tip of the snout (upper jaw) to the tip of the tail; standard length (SL), distance between tip of the snout (upper jaw) to the tip of the anal fin; pelvic fin length (PL), measured distance from the base to the tip of the pelvic fin; pre-pelvic fin length (Pre-PL), distance from the tip of snout to the base of the pelvic fin; head length (HL), distance between the tip of the snout to the upper operculum; body length (BD), distance between the base of the dorsal fin to the pectoral fin; snout length (SnL), distance between the tip of the upper jaw to the base of the eyes; check depth (CD).

The distance between the lower eyes and the operculum; eye length (EL), the bony diameter of the orbit; pre-dorsal fin length (Pre-DL), distance between the tip of the snout to the origin of the dorsal fin; dorsal fin length (DL), distance between the base of first dorsal to the last; dorsal spine length (DSL), the length of the last dorsal fin; anal fin length (ASL), distance from the tip of the anal fin to the last fin ray; length of third dorsal fin (LAF), the length of the third anal fin; Upper lip length (ULL), straight measurement between the snout tip and posterior edge of maxilla; lower jaw length (LJL), straight line measurement between the snout tip and posterior edge of mandible.

The Pre-pectoral length (Pre-PL) distance from the front of the pectoral base to the tip of the snout; Pectoral fin length (PL), distance from the tip of the pectoral to the base; caudal pundicle (CL), the least depth of the tail base and maximum vertical measurement of the mouth when opened(MT) distance between the lower lip and upper lip of the mouth.

Meristic count include number of dorsal fin (DF), anal fin (AF), pelvic fin (PF) caudal fin and pectoral fin (PeF)

Data Analysis

The data collected were subjected to multivariate analysis using the Principal Component Analysis because of its ability to virtualized high dimensional data, quantify differences among observed components, asses the quality of data while show casing the innate relationships between data point. The Unscramble$^@$ X version 10.4 software was used for the analysis, variation that could result from allometric growth were eliminated by standardizing and normalizing the morphology data to their standardized value

RESULTS

Score Plots

The score plots in figures 1a and 1b indicate that each of the observations only measures one value in the data set and each item has its (n) value in the component. The observed score value in the figures is a measure of the distance from the originated plot toward the first component and extends to the point where the observation extends to the direction vector (Bench mark), this gives value to the observation. The first score vector (PC1) is 58% and 44% in figures 1a and 1b respectively. The second score vector recorded a score of 27% in figure 1a and 38% in figure 1b. The pattern of the score observed gives direction to the formation of clusters in the component.

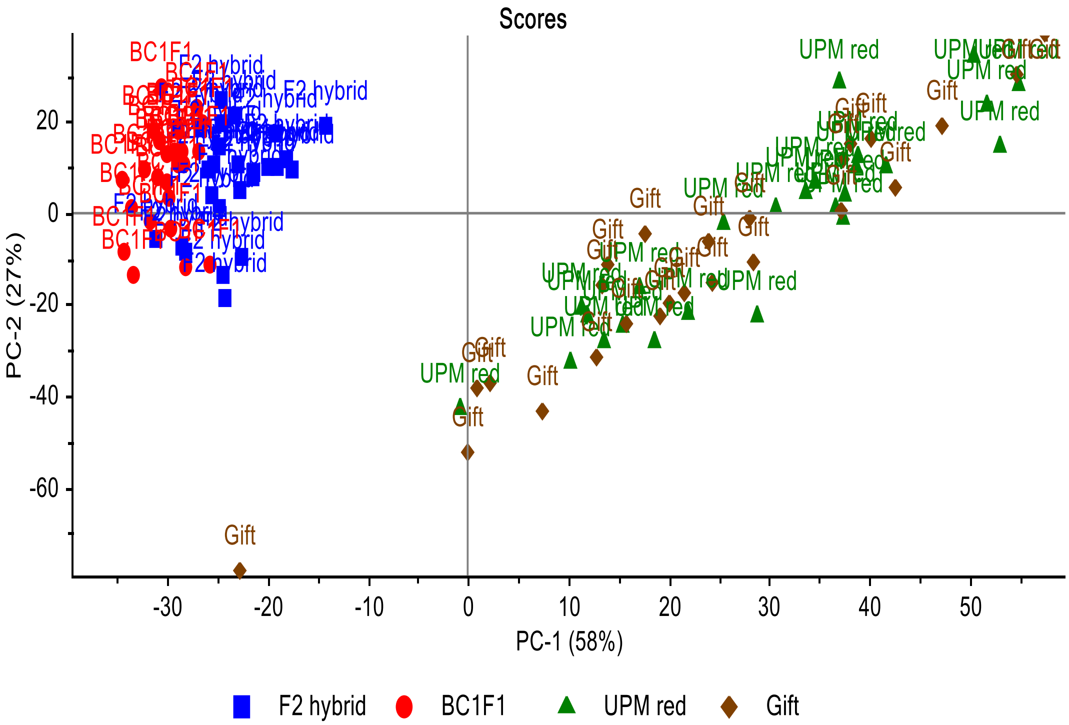

Figure 1a: Score plots for morphometric variables

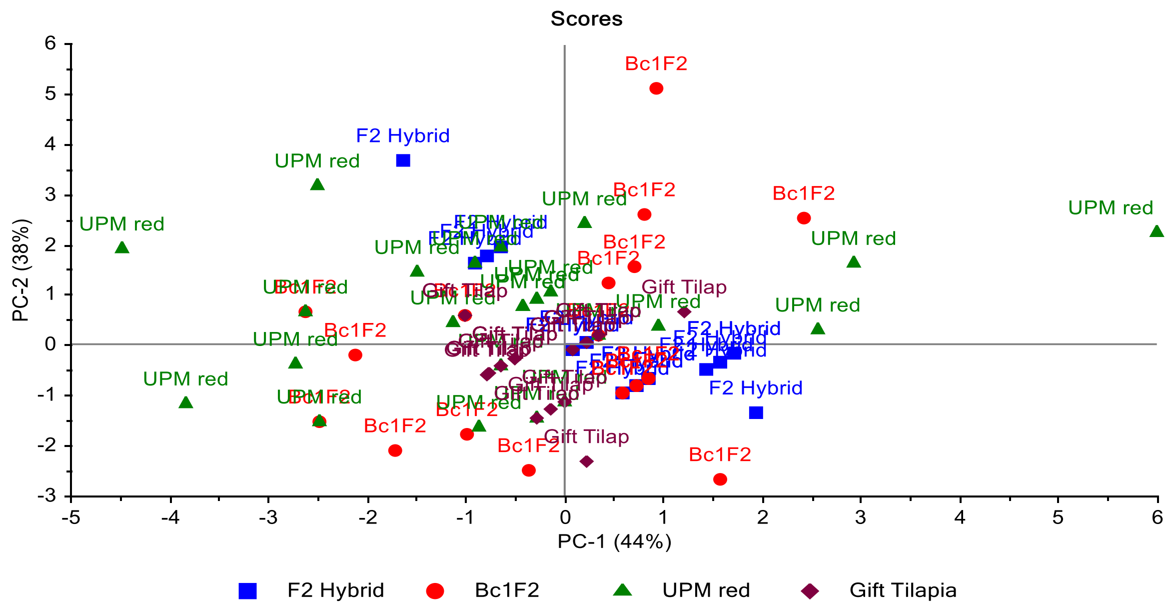

Figure 1b: Score plots for meristic variables

Correlation loadings

The loading plots which define the direction vector of the model as represented for the morphometric and meristic traits of the study is represented in Figures 2a and 2b. The PC1 vector in figure 2a gives the relationship between the point (where x and y is zero) at the same time the ability of the item to correlate with each other

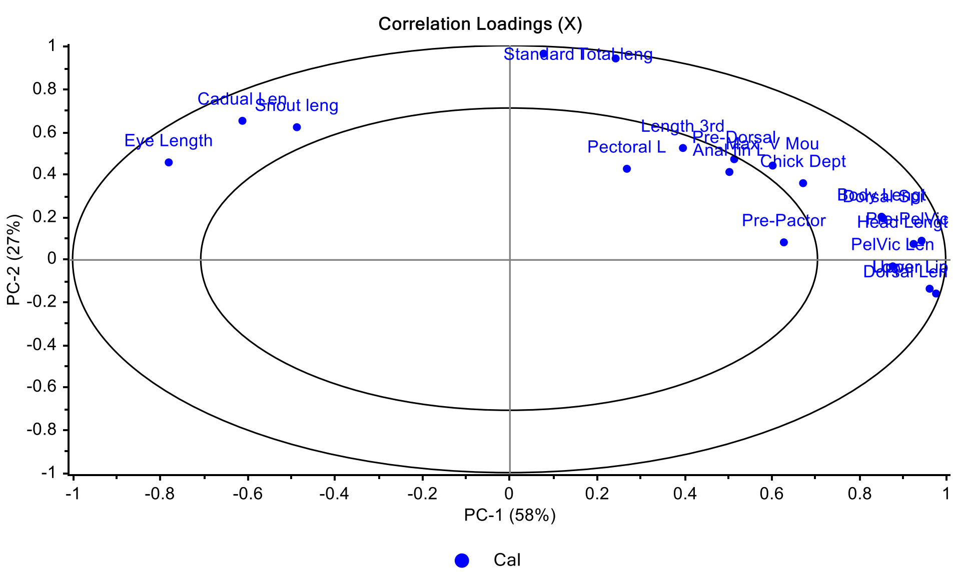

Figure 2a: Correlation loading plot for morphometric variables.

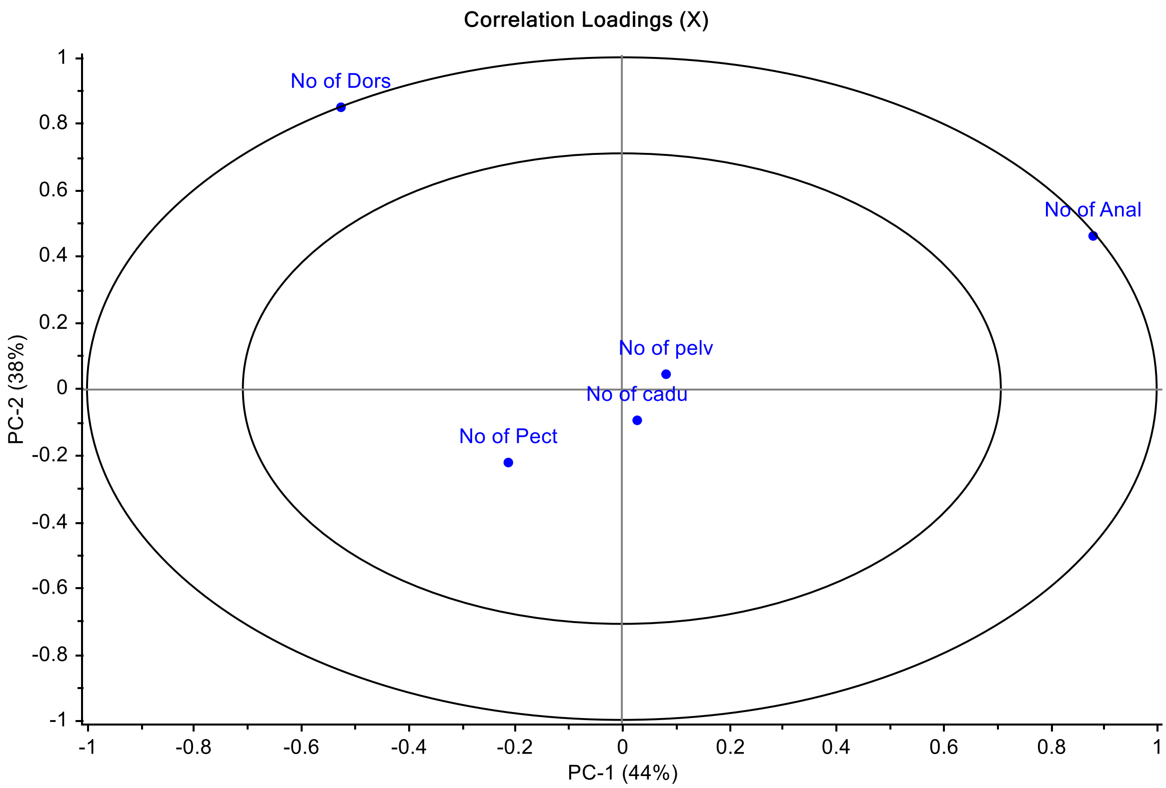

Figure 2b: Correlation loading for meristic variables

Biplots

A Biplots is a better form of scattered plots that uses scores and vectors to represent structures. The scores represent observations in Figures 3a and 3b while the vectors represent coefficients of the variables in the principal component (PC1 and PC2). In the figure 3a the scores represent distances measured from the tip of the lower lip of the fish while figure 3b has numbersof some of the appendages that are found on the fish. The vectors represent the different strains of fish (F2 Hybrid, Bc1F2, UPM red Tilapia and Gift Tilapia) whose morphometric and meristic traits were examined.

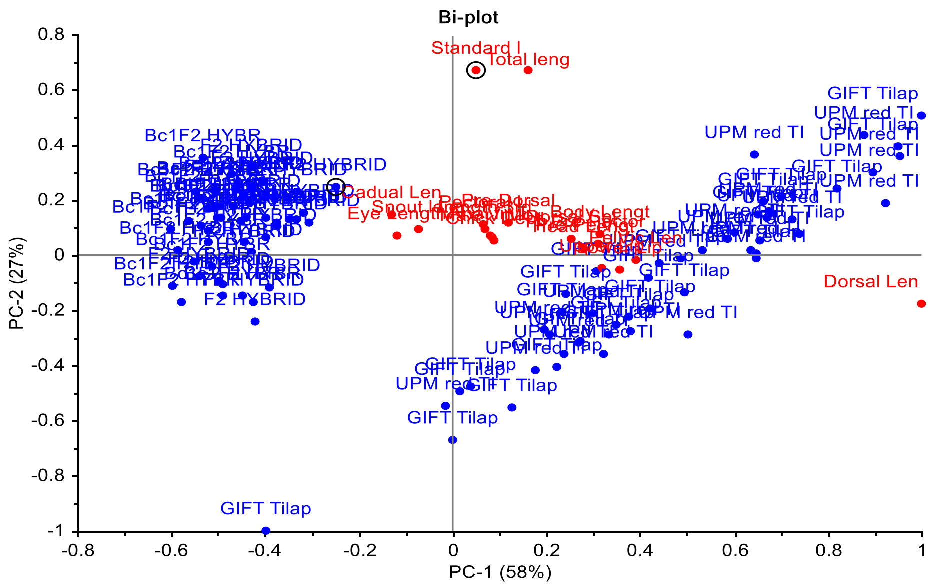

Figure 3a: Bi-plots for morphometric variables.

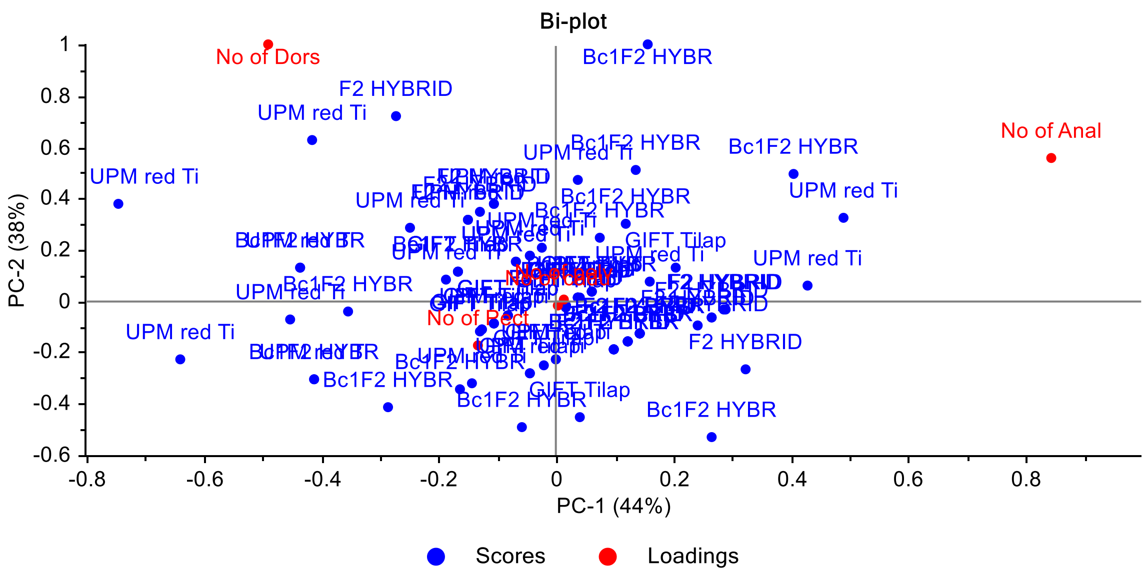

Figure 3b: Bi-plots for meristic variables

DISCUSSION

Morphometric Parameters

PCA analysis was performed on morphometric parameters. The morphometric parameters of the strains (F2 Hybrid, Bc1F2, UPM red Tilapia and Gift Tilapia) could be represented by the first 2 principal components (PC1 and PC2), respectively. From the score plot, 85% of the original variance in the data set (PC1: 58% and PC2: 27%) was explained by the first two principal components as shown in Figure 1a. The UPM red Tilapia and Gift Tilapia were found to be loaded on the positive axis of PC1and PC2 with overlapping between the two strains, the Backcross Bc1F2 and F2 Hybrid loaded on the negative side of both PC1 and PC2. In fact, the backcross could be clearly separated along negative side of the PC2 axis, which accounted for 27% of the total score, and F2 Hybrid could also be seen to be clearly separated along the same negative axis of the PC2 axis. Figure 1a shows an overlap of these two hybrids in the negative axis of the component which accounted for 27% of the total score. This is an indication that the original value of the hybrids (F2 Hybrid and Bc1F2) could be used to explain the variation in the parent stock UPM red Tilapia x Gift Tilapia. In addition, Figure 2a shows the correlation loading of all the morphometric variables (total length, standard length, pectoral length, pre-pectoral length, head length, body length, Snout length, chick depth, eye length, Pre-dorsal length, dorsal length, dorsal spine length, anal fin length, length 3rd anal fin, upper lip length, lower lip length, pre-pelvic length, pelvic length, caudal length, and maximum vertical mouth). From the figure, it can be seen that all except the caudal length, snout length and eye length morphometric variables, positively contributed to the overall classification of the four strains, with majority of the variables largely concentrated in the positive axis of PC-1 and PC-2 axis. This assertion was supported by Samaradivakara et al. (2012). while Ruiz-Campos et al., (2016) and Konan et al., (2010) were of the opinion that geographical location can bring variation in morphometric characteristics, the four strains examined were from same location and are genetically related. Figure 3a further shows the bi-plot of the PCA classification. From the plot it can be seen that this variables; total length, pectoral length, pre-pectoral length, head length, body length, chick depth, pre-dorsal length, dorsal spine length, anal fin length, length 3rd anal fin, upper lip length, lower lip length, pre-pelvic length, pelvic length, and maximum vertical mouth contributed to the classification of the four different strains, Thus, morphometric parameters can adequately distinguish samples of different tilapia strains.

Meristic Parameters

PCA analysis was also performed on meristic parameters. The meristic parameters of the strains (F2 Hybrid, Bc1F2, UPM red Tilapia and Gift Tilapia) could be represented by the first 2 principal components (PC1 and PC2), respectively, with 82% of the original variance in the data set (PC1: 44% and PC2: 38%) explained by the first two principal components as shown in Figure 1b. The score plot (Figure 1b) shows that the hybrids (F2 Hybrid, Bc1F2) load in the positive and negative axis of PC1 and PC2.Oladimeji et al., (2015); Turan et al., (2006) were of the opinion that meristic traits do not show any variation in species from different geographical locations.

This assertion is also evidenced in this current study, with result from the test fish could be related to the fact that the fish examined were genetically related (UPM Red Tilapia and Gift Tilapia were both hybrids of *Oreochromis niloticus* while the F2 Hybrid and backcross (Bc1F2) has both or one of the fish as its primary parent stock), they were also from the same geographical location. In addition, Figure 2b shows the correlation loading of all the meristic variables (dorsal fin, anal fin, pectoral fin, pelvic fin, and caudal fin). From the result, it can be seen that all variables are concentrated in the positive and negative axis of PC-1 and PC-2. Figure 3b further shows the Bi-plot of the PCA classification. From the plot it can be further seen that most of the variables are far from each other showing that there is no correlation between the variables and the variables on their own could not be used in effectively classifying the strains.

CONCLUSION

The hybrid of Gift tilapia was produced by crossing to UPM red tilapia while Principal component analysis were used for proper identification between the parents Gift Tilapia X UPM red Tilapia, their hybrids; F_2-Hybrid and $Bc1F_1$ backcross. Buss truss protocol was used to carry out the measurement and it was subjected to PCA analysis with the aid of Unscramble$^{@}$X statistical tools. The morphometric traits were found to be an effective means of explaining the strain while the meristic traits were not effectively able to separate the test fish based on their strains.

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