Assessing Genetic Variation in Fruit Components of Coconut Cultivars from NIFOR's Gene Pool

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Abstract

This study assessed the heritability of morphological traits in 12 coconut cultivars selected from NIFOR's coconut gene pool. The objective was to guide breeding programme and improve crop performance. A morphological study was conducted on fruit components, evaluating broad-sense heritability, genotypic variance, phenotypic variance and genetic advance. Result showed that husk weight had the highest heritability value (94.25%), while water weight had the lowest (39.29%). Genetic advance value ranged from 80.93 (water weight) to 194.16 (husk weight). Notably, 22 of the 30 examined traits exhibited high heritability values (60.20 – 94.25%), indicating a strong genetic influence. The findings suggest that selective breeding can effectively improve desirable coconut fruit traits, leading to enhanced crop performance. This research provides valuable information for coconut breeders seeking to optimize trait combinations.

Keywords: *Heritability, cultivars, traits, genetics*

Introduction

Coconut fruit is a fibrous drupe but with a smooth outside skin (exocarp), which may vary from green to red brown or even ivory. The ripe nut has a fibrous mass, the husk, from which coir is obtained. Within this fibrous mass is the nut with a hard shell (endocarp) enclosing the kernel (endosperm). Between the shell and the kernel is a thin brown seed coat (testa). It adheres firmly to the kernel which is the white flesh, about 12 mm thick lining the central cavity containing the nut water.

Considered as 'the tree of life' the coconut has a great variety of uses. Coconut oil and milk can be obtained from the solid albumen of mature fruits (copra), mainly from the tall varieties (Aragao *et al*., 2002). Coconut oil occupies an important position in the international market (Buschena and Perloff, 1991) showing potential application as a biofuel (Cloin, 2007).

Heritability helps breeders to predict how traits will be passed on to offspring, making selection more efficient. It enables breeders to identify and select for desirable trait combinations leading to improved crop performance. However, the heritability of coconut fruit component traits has not be determined in NIFOR coconut gene pool. Therefore, this study aimed at determining heritability in coconut cultivars.

Methodology

The experiment was conducted at the Nigerian Institute for Oil Palm Research (NIFOR), Benin City, Edo State. Morphological study was carried out on 30 traits of fruit components of twelve selected coconut cultivars. Four genotypes (palms) per cultivar were randomly selected and used for this study. Four nuts per palm were collected as samples for two years.

Data collected were subjected to analysis of variance. Genotypic variance, phenotypic variance, broad sense heritability and genetic advance of fruit component traits were calculated according to the method described by Singh and Chaudhary (1985), using the following formulae:

$$\sigma_g^2 = \frac{MS_g - MS_e}{r} \quad , \sigma_p^2 = \frac{MS_g}{r} \ ; \ h^2 = \frac{\sigma_g^2}{\sigma_p^2} * 100 \ ; \ GA = \frac{\sigma_g^2}{\sigma_p^2} K * 100$$

Where: σ_g^2 = Genotypic variance, σ_p^2 = Phenotypic variance

MSG = Genotypic mean square of the character; MSE = Error mean square of the character

X = General mean of the character, r = Number of replicates, K =selection differential of 2.06 at 5% selection intensity

Results

In Table 1, genetic variance values ranged from 0.32 (sugar content) to 78,715.25 (fruit weight) while phenotypic variance ranged from 0.42(sugar content) to 92,212.25 (fruit weight). The highest genotypic and phenotypic estimates were recorded for fruit weight 78,715.25, 92,212.25, nut weight 4,445.75, 8,362.33, seed weight 2,766.63, 5346.7, split nut 2,645.78, 4,201.6 respectively. The lowest component of genotypic and phenotypic variance was recorded for sugar content 0.32 and 0.42, followed by shell thickness 0.44 to 0.51 respectively. The highest heritability value (94.25%) was observed in husk weight while the lowest value (39.29%) was recorded in water weight. Notably, 22 of the 30 traits examined had high heritability. Genetic advance value ranged from 80.93 (water weight) to 194.16 (husk weight).

Table 1: Error variance, genotypic variance, phenotypic variance, broad sense heritability and genetic advance of fruit component traits in 12 coconut cultivars

Characters	MSG	MSE	Mean	σ_g^2	σ_p^2	h2	GA
Fruit weight (g)	368849	53988	916.02	78715.25	92212.25	85.36	175.85
Fruit length (cm)	79.1	41.7	26.39	9.35	19.78	47.28	97.4
L C of fruit (cm)	316.5	166.7	52.78	37.45	79.13	47.33	97.5
T C of fruit (cm)	47.4	14.9	44.57	8.13	11.85	68.57	141.24
Nut weight (g)	33449.3	15666.3	535	4445.75	8362.33	53.16	109.52
Nut length (cm)	5.2	1.5	17.01	0.93	1.3	71.15	146.58
L C of nut (cm)	21	6	34.02	3.75	5.25	71.43	147.14
T C of nut (cm)	30.9	10.2	32.42	5.18	7.73	66.99	138
Husk weight (g)	265004	15226.4	387.21	62444.4	66251	94.25	194.16
Husk thickness (mm)	389.4	31.7	25	89.43	97.35	91.86	189.23
Split nut (g)	16806.4	6223.3	399.57	2645.78	4201.6	62.97	129.72
Water weight (g)	5034.1	3056.3	135.23	494.45	1258.53	39.29	80.93
Water volume (cm^3)	5734.4	3237.1	135.93	624.33	1433.6	43.55	89.71
Shell weight (g)	3298.9	869.2	128.54	607.43	824.73	73.65	151.72
Shell thickness (mm)	2.04	0.3	3.4	0.44	0.51	85.29	175.71
Meat weight (g)	11241.1	4599.9	272.35	1660.3	2810.28	59.08	121.7
Meat thickness (mm)	4.4	1.9	11.31	0.63	1.1	56.82	117.05
Seed weight (g)	21386.8	10320.3	406.47	2766.63	5346.7	51.74	106.59
Sugar content (brix %)	1.68	0.39	4.62	0.32	0.42	76.79	158.18
% of nut in fruit (%)	1179.9	69.1	60.44	277.7	294.98	94.14	193.94
% of water vol. in nut (%)	125.9	40.6	24.42	21.33	31.48	67.75	139.57
% of husk in fruit (%)	856.7	94.1	40.3	190.65	214.18	89.02	183.37
% of shell in fruit (%)	43.1	13.4	14.55	7.43	10.78	68.91	141.95
% of water in fruit (%)	95.1	16.8	14.72	19.58	23.78	82.33	169.61
% of meat in fruit (%)	502.4	76.7	31.98	106.43	125.6	84.73	174.55
% of shell in nut (%)	64.7	11.4	24.29	13.33	16.18	82.38	169.7
% of meat in nut (%)	176.9	68.48	51.07	27.11	44.23	61.29	126.26
% of water in nut (%)	98.5	39.2	24.39	14.83	24.63	60.2	124.02
% of seed in nut (%)	64.8	11.4	75.71	13.35	16.2	82.41	169.76
% of seed in fruit (%)	910.6	74.6	46.47	209	227.65	91.81	189.12

L C =longitudinal circumference, T C = transverse circumference, % = percentage

Discussion

The heritability values obtained in this study were in agreement with that recorded by Asmono *et al*. (1993), who worked on genetic estimation of fruit component parameters of coconut populations. However, the heritability value (52%) for husk weight reported by these authors was lower than the value (94.25%) obtained in this study. Also, the heritability values obtained in this study were similar to that reported by Sivakumar *et al*. (2020). Sudha *et al*. (2019) observed heritability estimate in fruit weight (71.26), fruit length (46.17), transverse circumference of fruit (20.27), husk thickness (37.08), longitudinal circumference of nut (53.27) and transverse circumference of nut (20.74). These values are lower than that reported in this study. However, these authors' estimates in longitudinal circumference of fruit (53.09) and nut weight (69.33) were higher than that reported in this study. Heritability of fruit characters, such as fruit weight, husk weight, husk thickness, shell weight, endosperm (water) weight, albumen (water) weight, copra weight, oil content, fruit length and fruit width have been estimated on seven coconut populations by Asmono *et al*. (1993). The results showed that most of the fruit components had high heritability (>0.80). In this study, 11 out of the 30 traits investigated had heritability estimates greater than 80% while 22 of the 30 examined traits exhibited high heritability values (60.20 – 94.25%).

Conclusion

Nearly all the traits measured had high heritability estimates, suggesting that these traits are highly heritable and can be passed on to subsequent generation. Thus, there is high potential in the used of the cultivars for crop improvement programmes.

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