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Productive and reproductive performances of indigenous chicken under different rearing system

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Abstract

A survey study was conducted to analyze the reproductive and productive performances of four indigenous chicken breeds under different rearing system. Six villages located in Eastern Cape, South Africa were used for the study from July 2017 to June 2018. Data on clutch per year (CPY), hatchability (HATCH), egg per clutch (EGC), survivability at 10-12 weeks (SURV), egg per year (EPY), recovery period (RP), average age at production (AA), duration of rearing (DR), mortality, egg laying length (EGL), natural brooding period (NBP) and natural incubating period (NIP) were obtained from Seven thousand, five hundred and thirty eight (7538) indigenous chicken. Potchefstroom Kooekok is observed to be a good egg producing breed with 15.11±0.25eggs per clutch. Venda breed possess good mothering ability (hatchability) and high survivability with 86.03±0.31days and 82.70±0.26 days respectively. Naked Neck is known to be more prone to diseases with least (survivability) 60.08±0.25days. Village was positively correlated with EGC and HATCH, EGY and SURV at $p \leq 0.01$ and $p \leq 0.05$ respectively. Rearing system was positively correlated with EGC. Rearing system was positively correlated at $p \leq 0.05$ on EGC than CPY, HATCH, EGY and SURV. Breed and village interactions were significant at $p \leq 0.05$ on RP, AA, DR, EGL, NBP and NIP. Therefore, productive and reproductive traits of indigenous chicken differ across different rearing systems, breeds and villages.

Keywords: productive, reproductive, breed, indigenous, traits, poultry

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Introduction

Indigenous poultry production plays a vital role in national economy with approximately 80% poultry products gotten from local communities (Sharma, 2010). Chicken meat assumed to be the most consumed among other poultry products (Sharma, 2010). Chicken consumption is expected to increase yearly due to high demand rate, low price, little or no religious limitation, high digestibility, good taste and low calorie (Raphulu *et al.*, 2015). There are different types of indigenous breeds recognized in South Africa poultry production. Such breeds are Ovambo, Venda, Potchefstroom Kooekok and Naked Neck (Mtileni *et al*., 2010). They are regarded as conservative breeds with divergent productive traits capacity but not documented (Mtileni *et al.*, 2010). Egg production among other poultry products in South Africa has contributed greatly to National gross income up to R2.7 million at producer level (Alabi *et al.*, 2012). But mortality, predator, accident and diseases are among threats faced by farmers (Krishna *et al.*, 2012). Poultry production success can be greatly attributed to constant supply of day old chicks. However, indigenous poultry farmers' embrace natural hatching system (Abdurehman and Urge, 2016). Despite the low turnover from indigenous chicken most rural farmers prefer to raise them than exotic breeds. These are due to high resistant to disease, great resilient ability to diseases, high adaptability, good scavenging ability and ability to live without structured feeding (Ajayi 2010). In an attempt to increase poultry production; hatchability and high level of survivability cannot be over looked (Ajayi and Agaviezor 2016). Hatchability and fertility determine levels of reproduction from the quantity of breeding stock within a phase of time (Obike *et al.*, 2014; Ajayi and Agaviezor, 2016). As such, they vary across different breeds and diversified within same breed depending on genetic and environmental influence (Ajayi and Agaviezor, 2016). Indigenous chickens are capable of exhibiting 7-9 major genes in their gene pool which are genetically

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preserved for harsh environment. Due to presence of this "utility" gene they are preferred to be used for genetic exploration and easily managed by indigenous poultry farmers (Ajayi, 2010). Matured hen are expected to lay thirty (30) dozen eggs in a life time (DOA, 2011). In a study in Nigeria, egg per clutch ranging from 4 to 14 eggs but averagely 9 eggs (Onasanya and Ikeobi, 2013). Ikeobi et al. (1996) explained that 8 to 9 eggs are laid between 2 to 14 days within 32 to 36 weeks during laying stage. It is assumed that villagers have more access to great quality protein through consumption of meat and eggs from their chickens (Ndofor *et al.*, 2015). Perhaps, this may enhance their wellbeing status, ease ailing health and enhance food security. Nevertheless, the productive performance of breeds available in indigenous poultry production in South Africa has been vaguely evaluated. Therefore, this study aims at determining the reproductive and productive performance of indigenous poultry in different rearing system, villages and breeds.

Materials and Methods

Study site description

The experiment was conducted in three towns (Willowvale, Idutywa and Mthatha) in Eastern Cape Province. Out of which six different villages (Falakalha, Ciko, Gosani, Dokodela, Nqabarha and Ludondolo) were randomly sampled using snow ball sampling techniques. These villages were selected in different geo-political zones but farmers practice indigenous poultry production. A pre-visit test was done to interview the deputy director of rural development and agrarian reform.

Sampling of chicken and household

Indigenous chickens were sampled with one hundred and sixty (160) farmers. Questionnaire, focal discussion and group discussion were used to acquire information with the help of poultry farmers and extension officer. All sampled farmers were practicing indigenous poultry production.

Data collection

Data on some productivity and reproductive traits were collected within a timeframe of 12 months (July 2017- June 2018). Productivity parameters taken were average eggs per clutch, average egg per year, clutch per year, survivability at 10-12 weeks, age to reach productivity, clutch length per year, average age at first lay, chicks, pullet, cock, laying hen, layers incubating, layers brooding, duration of rearing, natural incubation period and natural brooding period. The number of chicks hatched per sampled hen was recorded. Morbidity and mortality of chicks were measured and recorded. Hatchability was determined as the proportion of eggs laid to the hatched chicks

Determination of sexual maturity

To determine sexual maturity, day old chick's age to production of first egg was calculated from the hatching date of the hen to the production of the first egg.

Determination of total number of eggs produced per production cycle

Average of two production cycles =

$$\frac{\text{Total number of eggs produced per hen per production cycle}}{\text{Total number of hen alive during production cycle}}$$

Determination of mortality rate

% of Mortality as calculated by =

$$\frac{\text{Number of dead birds}}{\text{Total number of birds nurtured}} \text{X100}$$

Statistical Analysis

The data collected were stored in Microsoft excel sheets. SAS (2003) software was used for analyzing data on reproductive and productive traits performances. Mean comparison of traits was achieved using Tukey's Kramer Least Significant Difference. Least square means was computed using GLM procedure of SAS. The significance level selected on the mean differences was 5% and 1% respectively.

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Results

Effect of breed of chicken on egg production

Effect of breeds on traits (Table 2) CPY and EGY were non- significant at P≤0.05. However, the effect of breed on EGC, HATCH and SURV of indigenous chickens were significant.

Table 1. *Flock size across households that practice indigenous poultry (N = 7538)*

Chicken age group	Villages (Mean± SE)					
	Falakahla	Ciko	Gosani	Dokodela	Nqabarha	Ludondolo
Chicks	4.16±1.1^{NS}	5.83±1.1^{a}	6.37±1.2^{b}	6.80±1.2^{b}	6.50±1.4^{b}	7.09±1.9^{NS}
Cock	6.12±1.3^{a}	7.16±1.3^{a}	9.14±1.4^{ab}	11.38±1.4^{b}	9.80±1.6^{ab}	9.36±2.1^{ab}
Laying	2.74±0.9 ^{NS}	4.26±1.0^{a}	4.51±1.1^{a}	5.92±1.1^{b}	5.81±1.2^{b}	4.81±1.6^{NS}
Hen	18.67±4.1^{a}	23.36±4.2^{a}	26.0±4.4^{ab}	32.23±4.4^{b}	26.10±5.1^{ab}	25.9±6.9^{ab}
Lay- Incubating	1.38±0.6^{NS}	2.60±0.6^{a}	2.74±0.7^{a}	3.15±0.7^{a}	2.65±0.8^{NS}	2.45±1.0^{NS}

SE= Standard error, NS means Not significant; (*) means significant at 0.05; (**) means significant at 0.01

There are variations in flock size with hen having the highest (4094), followed by cock (1413), chicks (960), laying hen (684), and incubating layers (387). The mean of chicks (23.13), cock (8.82), chicks (7.46), lay incubating (4.78), and laying hen (2.9).

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Table 2. Least square means ± standard error of productive traits of indigenous chicken

NS means Not significant; (**) means significant at 0.05; (***) means significant at 0.01. NN: Naked Neck. ***OV:***

FACTORS		TRAITS				
		EGC	CPY	HATCH	EGY	SURV
Breed	VN	13.36±0.31[b]	4.17±0.16	86.03±0.31[c]	55.71±2.14	68.70±0.26[c]
	PK	15.11 ±0.25[b]	3.22±0.13	81.83±0.39[b]	60.28±1.75	75.48±0.21[b]
	OV	11.37±0.30[ab]	3.71±0.15	79.61±0.41[a]	42.18±2.04	71.13±0.25[ab]
	NN	9.69±0.30[a]	3.56±0.15	80.26±1.81[ab]	34.49±2.65	60.08±0.25[a]
		**	NS	**	NS	**
Village	Falakahla	13.37±0.24[c]	3.66±0.12	73.94±0.48	39.96±1.66	66.08±0.20[c]
	Ciko	10.69±0.34[ab]	4.33±0.17	72.19±0.44	40.41± 2.31	58.33±0.28[b]
	Gosani	10.69±0.36[ab]	3.96±0.18	75.58±0.50	30.20±2.50	49.49±0.29[a]
	Dokodela	9.43±0.35[a]	4.80±0.18	73.24±0.50	36.38±2.40	47.30±0.29[a]
	Nqabarha	11.76±0.41[b]	3.91±0.21	72.80±0.55	33.61±2.83	58.59±0.35[b]
	Ludondolo	11.10±0.76[b]	3.63±0.36	75.83±0.67	33.23±4.80	56.65±0.59[ab]
		***	NS	NS	NS	**
Rearing System	Cage Con.	12.77±0.5[b]	3.81±0.46	72.86±0.44	36.45±2.79	59.27±0.35
	S.I	12.36±0.3[b]	3.99±0.27	70.06±0.27	36.92±1.64	57.26±0.21
	U.S	11.33±0.5[ab]	3.90±0.46	74.61±0.46	33.09±2.85	48.85±0.36
	Scavengers	10.70±0.5[a]	4.80±0.47	73.80±0.47	40.95±2.92	49.80±0.37
		**	NS	NS	NS	NS

SE= Standard error, NS means Not significant; (*) means significant at 0.05; (**) means significant at 0.01

Ovambo, VN: Venda, PK: Potchefstroom Kooekok, Cage Conf: Cage Confinement S.I: Semi Intensive, U.S: Unimproved Scavengers, EGC: Egg per clutch, CPY: Clutch per year, HATCH: hatchability, EGY: Egg per year, SURV: Survivability

Effect of village on egg production

Effect of village on egg production (Table 2) CPY was non-significant at P≤0.05. Nevertheless, the effect of village on EGY, HATCH, EGC and SURV were significant across different villages.

Effect of rearing system on egg production

Effect of rearing system on egg production (Table 2) EGC was significant (P≤0.05) while CPY, HATCH, EGY, SURV were non-significant across different rearing system method in different villages**.**

Correlations among productive traits of indigenous chickens

Correlations of EGC, HATCH, SURV, CPY and EGY were 0.81±0.02, 0.50±0.04, 0.25±0.06, 0.66±0.04 respectively (Table 3). Correlation between survivability and CPY is 0.05±0.02 and EGY and CPY is 0.11±0.03.

Table 3. Correlation among productive traits of indigenous poultry

Traits	Correlation ± SE of correlation				
	EGC	HATCH	SURV	CPY	EGY
EGC	1	0.81±0.02**	0.50±0.04***	0.25±0.06**	0.66±0.04***
HATCH	0.81±0.02**	1	0.54±0.03***	0.28±0.07***	0.47±0.05**
SURV	0.50±0.04***	0.54±0.03***	1	0.05±0.02NS	0.36±0.07***
CPY	0.25±0.06**	0.28±0.07***	0.05±0.02NS	1	0.11±0.03NS
EGY	0.66±0.04***	0.47±0.05**	0.36±0.07***	0.11±0.03NS	1

Note: NS = Not significant , (**) significant at 0.05% level of probability (P≤0.05), (***) significant at 0.01% level of probability (P≤0.001), EGC- egg per clutch, CLY- clutch per year, HATCH- hatchability, SURV- Survivability. SE: Standard error

Discussion

Flock size and structure in different villages

Average household has 25.52 hens, 8.83 cocks, 5.84 laying hens, 4.46 chicks and 2.41 laying hens in this study. This finding is against the finding of Hailemichael et al. (2017) who reported 7.66 hens, 2.84 cocks, 1.85 for pullets and chicks. The recorded changes could be attributed to different sample size and different agro ecological zone. This study observed cock: hen ratio of 1:3. This is in accordance to national ratio in Ethiopia 1:3. Nevertheless, there was a slight variation from the ratio of hen and cock of 1:4 reported by Dessie (1996). There was low number of male (cock) compared to female (hen) in this study. Reasons were accorded to palatability and taste preference of cock, more profit at point of sales and are mostly kept purposely for mating. These reasons were also reported by Dessie, (1996) and Hailemichael et al. (2017). As temperature, rainfall and atmospheric humidity changes, metabolic and physiological activities of fertile eggs are affected. Such activity leads to infertility and reduction in hatchability among indigenous eggs. Onasanya and Ikeobi (2013) also reported similar situation in their finding. Most farmers explained that the thickness of the shell influence the rate of hatchability. In addition, shell thickness influences permeability of water vapour which thus affects hatchability. Success and effectiveness of indigenous poultry production can be attributed to number of egg laid and number of fertile egg hatched.

Productive traits of indigenous chicken

Effect of breeds on productive traits

Effect of breed (Table 2) on EGC, HATCH and SURV was significant. This could be attributed to genetic disparity existing across the rearing system regarding different place and stage of purchase. HATCH is determinant of EGC. It means the hatchability has a correlation with breeds available.

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Level of hatchability differs across the breeds. Nevertheless, seasonal variation has an effect on hatchability across different villages. High ambient temperature and low humidity results in lowering rate of hatchability. Thus, leads to lower levels of hatchability during summer period contrasted to winter, summer and spring. Survivability is based on variation in levels of mortality, theft factors, disease infection and is significant across different breeds. EGY is mostly based on age of the hen, rearing system and feed. This study reveals that Potchefstroom Kooekok has the highest EGC (15) averagely while Venda breeds has highest (4) CPY. This finding is in agreement with Hossen, (2010) and Massaire et al (2018) who reported 3-4 CPY. This could be as result of feeding and rearing system adopted. But in deviation with Lanada et al (2011) who reported 8 eggs per clutch. This study recorded average of 48 eggs per year. This finding is in agreement with Sears et al.(2011) but slightly higher than report by Dessie et al (1996) who reported 40 eggs. Based on this study, VN, PK, OV and NN had 58, 60, 42 and 34 EGY respectively. OV and NN agrees with finding of Sears et al.(2011) and PK agrees with findings of Moges et al. (2010).This study observed EGC varying from 9 to 15eggs. This finding is similar to the described 9-19 eggs in North West Ethiopia (Halima 2007; Moges *et al.*, 2010). There could be association between low productivity, ability to withstand harsh temperature and late maturity in the genetic pool of indigenous chicken. This study reported that hatchability varies across different seasons as season and nutrition has influence on hatchability levels of indigenous chickens.

Effect of villages on productive traits

Effect of village (Table 2) on EGC and SURV were significant. EGC across different villages differs based on gene pool of chickens across different villages. Chickens in different village exhibited different phenotypic and genotypic expression. This is due to different parents and different generation intervals recorded in each village. In addition, level of survival was

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determined by varied ability to withstand diseases and to escape from predators. EGC varies from village (9.43±0.35 Dokodela) to (13.37±0.24 Falakahla). SURV varied from (47.30±0.29 Dokodela) to (66.08±0.20 Falakahla).

Effect of rearing systems on productive traits

Effect of rearing system (Table 2) on CPY, HATCH, EGY and SURV was non-significant. Rearing system was significant on EGC. Rearing system adopted by farmers has a direct effect on EGC. In an enclosed chicken house, poultry animals tend to lay eggs without fear of theft or predators. EGC can be more precise and accurate depending on rearing system adopted. EGC varied across different villages from scavengers 10.70±0.5 to cage confinement 12.77±0.5.

Correlation among productive traits

This finding reveals high level of significance across all the productive traits in area of study. EGC and HATCH (0.81±0.02) and EGC and SURV (0.50±0.04) has high level of significance respectively, EGC and CPY (0.25±0.06 medium level) and EGY and EGY (0.66±0.04 medium level) respectively. Based on this finding, selection for advanced positive value of any traits will affects other traits. This reveals high level of dependency across all reproductive traits like EGC, HATCH, SURV, CPY and EGY.HATCH is reliant on broody hen's health status, environment temperature, maternity instinct, mothering ability, commitment to incubation activities broody. Different levels of correlation were observed such as (high and medium level). It can be statistically induced that interest in improving any trait will simultaneously improve the other traits and otherwise. This result agrees with Jahan et al. (2017).

Reproductive traits of indigenous chicken production

Effect of reproductive traits (Table 4) on AA, EGL, NBP, and NIP was significant. This finding reveals high level of significance across AA, EGL, NBP, and NIP. All these factors are positively correlated to each other. There is a strong correlation between AA, EGL, NBP and NIP across different villages. Broodiness is explained as manipulated environmental inhibiting self-induced stimuli that facilitate nesting behavior. Motivations like constant removal of fertilized eggs and bridging a gap between chicks and mother were adopted by farmers has these practices caused reduction in mothering instinct of the hen and levels of hatchability.

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Table 4. Least square means ± standard error of reproductive traits of indigenous chicken
SE= Standard error, NS means Not significant; (*) means significant at 0.05; (**) means significant at 0.01

FACTORS		TRAITS							
		RP	CL	AA	DR	Mortality	EGL	NBP	NIP
Breed		NS	NS	**	NS	NS	**	**	***
	VN	19.64±0.2[ab]	16.89±0.2	124.08±0.2[a]	82.36±0.4[a]	30.51±0.4	158.89±3.1[b]	56.330±0.1[b]	21.17±0.8[a]
	PK	18.55±0.2[a]	16.86±0.2	128.15±0.2[b]	82.06±0.4[a]	55.60±0.4	141.50±3.3[a]	56.84±0.1[a]	21.05±0.9[a]
	OV	19.18±0.2[ab]	16.72±0.2	127.98±0.2[b]	82.81±0.4[a]	36.40±0.5	147.93±3.4[ab]	56.25±0.1[a]	21.29±0.9[a]
	NN	20.09±0.3[b]	16.69±0.2	126.09±0.3[a]	83.70±0.6[b]	70.94±0.7	150.72±4.7[ab]	56.09±0.2[a]	21.42±0.1[a]
	Breed x village	**	NS	**	**	NS	**	**	**
Village									
	Willow-vale	19.16±0.2[a]	16.63±0.2	126.80±0.2[a]	83.29±0.9	40.82±0.5	158.98±3.5[b]	56.28±0.1[a]	21.10±0.1[a]
	Ciko	21.55±0.3[b]	16.74±0.2	128.41±0.2[b]	81.74±0.4	57.91±0.5	160.51±3.5[b]	56.14±0.1[a]	21.12±0.1[a]
	Gosani	18.03±0.3[a]	16.94±0.2	124.27±0.2[a]	81.68±0.5	47.89±0.5	147.12±3.6[a]	56.61±0.1[a]	21.42±0.1[b]
	Dokodela	20.32±0.4[b]	17.04±0.2	125.31±0.2[a]	82.56±0.5	46.32±0.5	149.26±3.6[ab]	56.38±0.1[a]	21.41±0.1[b]
	Nqabarha	19.60±0.3[a]	16.65±0.2	126.67±0.2[a]	83.79±0.6	37.30±0.6	157.07±4.2[b]	56.32±0.1[a]	21.33±0.1[a]
	Ludondolo	19.70±0.7[a]	16.80±0.3	126.56±0.2[a]	82.71±0.8	47.71±0.2	142.90±5.8[a]	56.32±0.1[a]	21.28±0.2[a]
	Village x rearing	**	NS	**	NS	NS	**	**	**
Rearing System									
	Cage Con.	19.49±0.3[a]	16.99±0.2	128.05±0.3[b]	81.94±0.7	36.18±0.7	158.19±5.3[b]	56.38±0.2[a]	21.19±0.1[a]
	Semi- Intensive	19.76±0.2[a]	16.88±0.1	123.32±0.1[a]	82.28±0.3	57.96±0.3	160.06±2.5[b]	56.20±0.1[a]	21.29±0.0[a]
	Un. Scavengers	20.65±0.2[b]	16.74±0.2	124.67±0.2[a]	82.40±0.4	67.61±0.4	142.85±3.0[a]	56.67±0.1[a]	21.02±0.1[a]
	Scavengers	21.49±0.3[b]	16.85±0.2	128.71±0.2[b]	82.89±0.5	69.43±0.5	147.75±3.9[a]	56.29±0.1[a]	21.19±0.1[a]
	Breed x rearing	**	NS	**	NS	NS	***	**	**

Effect of breed and interaction between breed and village

Effect of breed on RP, AA, DR, EGL, NBP and NIP of indigenous chicken (Table 4) was significant ($p \leq 0.05$) although the effect of CL and mortality were non-significant. High significant levels were observed between breeds and village interactions RP, AA, DR, EGL, NBP and NIP, while breeds and CL and mortality have no significance CL, DR and mortality. Differences in AA may be due to unstructured mating system adopted by farmers. Genetic differences exist within the breeds from one generation to another. Venda breed is known to have small body size, which could be responsible for early attainment to sexual maturity. Among other factors like nutrition, day length and other environmental induced factors.

Effect of village and interaction between villages and rearing system

High significance correlation was observed between village and rearing system interaction RP, AA, EGL, NBP and NIP which means that as one trait increases other traits increases. Nevertheless, there was no significance correlation between CL, DR and Mortality in Table 4.

Effect of rearing system and interaction between breed and rearing system

High significance correlation was observed between breed and rearing system RP, AA, EGL, NBP and NIP but non-significant between CL, DR, and Mortality (Table 4). This study recorded 16 days for length of clutch. This agrees with Aganga et al. (2000). Recovery period of this study was 18-21 days. Duration of Rearing of this study was 82days. This is slightly different by +3days (85 days) in similar study by Aganga et al. (2000). This study observed 141 -160 days for EGL. This disagrees with Gueye (1998) who reported 168-224 days for EGL. Natural incubating period and natural brooding period of this study is 21 and 56 days respectively. This finding agrees with Aganga et al. (2000); Moges et al (2010) and Zewdu et al (2013). In this study, average age of at first lay is 126 days. This approves with Farooq et al. (2002). This finding is in discrepancy to projected age of 28 weeks reported in Tanzania (Halima *et al.*, 2007), 32 weeks in Nigeria and Sudan (Bobbo *et al.*, 2013) and 25 weeks in Senegal (Halima *et al.*, 2007). The differences observed could be attributed to geographical location, germline differences, nutrition or feeding plan and management practices.

Conclusion and Recommendation

There was a significant correlation between all chicken ages of group across different villages, breeds and rearing systems. Potchefstroom Kooekok breed is known as egg producing breed with high survivability level, Venda breed has highest hatchability level and Venda breed is known to lay eggs four (4) times in a year. Correlations between productive traits were all positively correlated across different villages. Significant correlation was recorded among RP, AA, DR, EGL, NBP and NIP among the reproductive traits. This study showed that most of the traits are positively correlated to others. This depicts that selection of one traits may improve other traits as they are positively correlated to each other. Therefore it can be concluded that productive and reproductive traits vary across different rearing system, breeds and villages.

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Author's Contributions

Peter Ayodeji Idowu: Proposed after envisioning the research, received funding for the project, analyzed data, interpreted the result discussed and prepare the manuscripts

Maliviwe Mpayipheli: supervised the project, provided grants for the research and went for data collection.

Voster Muchenje: co-supervised the research and advised on research methodology.

Ethics

Ethical clearance was applied for before the commencement of this research under University of Fort Hare Research Ethics Committee with certificate reference number (MPA031SIDO01)

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