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PERFORMANCE, CARCASS, HAEMATOLOGY AND BLOOD CHEMISTRY OF BROILERS FED ON COOKED WILD COCOYAM [*Colocasia esculenta* (L.) Schott] CORMS AS PARTIAL SUBSTITUTES FOR MAIZE

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ABSTRACT

A 28-day feeding experiment was carried out to investigate the performance, carcass and health status of broilers fed Cooked Wild Cocoyam [*Colocasia esculenta* (L.) Schott] Corm (CWCC), as partial substitutes for maize. One hundred and twenty (120) 4-weeks old Hybro broiler chicks were randomly distributed to four dietary treatments of three replicates each. There were 10 birds per replicate in a completely randomized design experiment. Four diets were formulated such that diet 1 contained no CWCC and served as the control, while diets 2, 3 and 4 contained 10, 20 and 30% CWCC respectively. Results indicated that the highest weight gain (304.48g/b/wk) obtained in the control reduced to 260.87, 254.58 and 253.03g/b/wk respectively for birds fed 10, 20 and 30% CWCC-based diets ($P < 0.05$). The feed conversion ratio (2.56) of birds fed with 0% CWCC-based diet increased to 2.92, 3.12 and 3.24 respectively for those fed 10, 20 and 30% CWCC-based diets ($P < 0.05$). Mortality was the same across all dietary treatments. The dressed weight (64.78%) of the control decreased to 62.93, 61.01 and 60.57% respectively for birds fed 10, 20 and 30% CWCC-based diets($P < 0.05$).The heart weight (HW) and gizzard weight (GW) differed significantly ($P < 0.05$) across the dietary treatments. All the haematological parameters did not differ ($P > 0.05$) among the dietary treatments. The value of cholesterol was 134.54, 132.80, 125.48 and 121.91mg/dl respectively at 10, 20 and 30% CWCC. Cost of a kilogramme of feed significantly ($P < 0.05$) decreased from ₦50.01 (control) to ₦38.42 (10% CWCC), ₦36.84 (20% CWCC) and ₦35.26 (30% CWCC) respectively. Cost of feed per kilogramme weight gain(₦127.86) obtained in birds on control (0% CWCC-based diets) was significantly ($P<0.05$) higher than ₦112.19, ₦114.82 and ₦114.36 respectively for 10, 20 and 30% CWCC-based diets. Although substitution of maize with CWCC at 10-30% was cheaper than control with no adverse effect on bird's health, however, the weight gain, dressed weight, cost per kg feed and cholesterol level decreased ($P < 0.05$) with increasing substitution levels and birds fed 10% CWCC-based diets had the least cost of feed per kg live weight gain. Therefore, 10% level of substitution was recommended for optimum profitability.

Keywords: Cooked wild cocoyam, anti-nutrients, broilers, blood indices, replacement, performance

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INTRODUCTION

High cost of conventional energy feed ingredients like maize, sorghum, guinea corn, wheat and many others has necessitated the need for alternatives. These alternatives are agro-industrial by-products (AIBs), root and tuber crops including their wild cultivars which are not edible to man among others. Unconventional feedstuffs are more likely to be available for use for livestock feeding at lower costs. Price per standard unit of feed compounded from the use of these ingredients is bound to be cheap. Such a cheap price is beneficial and attracts the poor livestock farmers [1].

Techniques are available to assess the nutritive value of such unconventional feedstuffs. In addition to performance and carcass evaluation for example, additional studies could be employed to establish the impact of the use of such feedstuffs. In order to fully understand the possible impact of the use of unconventional feedstuff, there may be the need for additional studies on growth performance, carcass composition and nutrient utilization of the feedstuff and diets in which the feedstuff is incorporated [2]. One of such studies is the health assessment impact of unconventional feedstuff incorporated into livestock diets. The purpose of investigating blood composition is to be able to distinguish the normal state from the state of stress. The stress factors could be nutritional, environment or physical. Serum or plasma chemical values are useful in the assessment of the nutritional and health status of animals. For example, the aim of estimating the haemoglobin content of the blood is to determine the oxygen carrying capacity of the bird's circulatory system [3]. Dietary components have measurable effects on blood components and such blood constituents are widely used in nutritional evaluation of animals [4, 5].The blood variables most consistently affected by dietary influences include red blood cell counts, packed cell volume, plasma protein and glucose [6]. Packed cell volume and haemoglobin were directly related to the nutritional balance of the diet fed to the animal. Decrease in total protein could be attributed to inhibition of protein utilization [4, 7]. This study was carried out to investigate the performance, carcass, haematology and serum metabolites of hybro broilers fed graded levels of Cooked Wild Cocoyam Corm Meal- based diets.

MATERIALS AND METHODS

Site of the experiment

This study was conducted at the rearing section of the Poultry Unit of the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria. The location of the experiment is $7^0$27'N and $3^0$45'E at altitude 200-300m above sea level; mean temperature of 25-29^0 C and the average annual rainfall of about 1250mm[8].

Chemical analysis

The processing technique, nutrient and anti-nutritional contents of the cooked wild cocoyam [*Colocasia esculenta* (L.) Schott] corms (CWCC) were as earlier reported Olajide *et al*. [9]. Briefly, a batch of thoroughly washed, sliced, unpeeled corms of this cultivar of wild cocoyam were collected in a cooking pot filled with water and heated at 100^0 C for about 15 minutes according to method of Babayemi and Bamikole [8] modified. This was sun-dried for 12 days and thereafter analyzed. Samples of the

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experimental finisher diets were analyzed for proximate chemical composition using AOAC method [10]. Nitrogen Free Extract (NFE) was determined by difference and Metabolisable Energy (ME) calculated according to the procedure of Pauzenga [11] as:

$$ME\ (kcal / kg) = 37 \times \%\ Protein + 81.8 \times \%\ Fat + 35.5 \times \%\ NFE$$

Preparation of experimental diets

Four diets were formulated with partial substitution (weight for weight) of maize with CWCC. Diet 1 contained no test ingredient (CWCC) and served as the control. Diets 2, 3 and 4 contained 10, 20 and 30% CWCC. Each of the diets represented a treatment.

Management of the experimental birds

The birds were raised on litter (wood shavings) of good absorbent quality and artificial light (electric bulb) provided to encourage the birds to eat at night. One hundred and twenty (120) hybro broiler finishers, 4 weeks old which were obtained from the previous study (Starter phase) were used for this experiment. The birds were randomly distributed to four dietary treatments of three replicates each. There were 30 birds of similar average weight per diet at the rate of 10 birds per replicate. Feed and water were provided *ad libitum*. The birds were weighed and feed intake recorded weekly. Feed intake was determined as the difference between feed supplied and that remaining at the end of the week.

Carcass traits

Carcass evaluation of the birds previously fed graded levels of CWCC-based diets were carried out at the Meat Science Laboratory of the University of Ibadan, Nigeria. Forty eight (48) birds, 12 birds per diet were randomly selected for carcass analysis, at the end of feeding trials which lasted 4 weeks. Prior to slaughtering, the birds were starved for about 12 hours overnight, but allowed access to water. The fasted live weights were recorded. The birds were bled and hung upside down to ensure proper bleeding. Each of the carcasses was thoroughly bled, scalded, de-feathered and eviscerated according to the procedure of Jones [12]. The plucked and eviscerated weights were calculated as percentages of live weight.

The carcass, some inner organs (kidneys, lungs, heart, liver and gizzard) and offal were weighed and recorded. The organ weights were calculated and expressed as percentages of carcass weight.

Haematology and biochemical indices

At the end of the feeding trial, 4 birds per replicate (12 birds per treatment and 48 birds in total) were selected and bled by the jugular vein using a hypodermic needle with a syringe. Blood of each bird was drained into two different carefully labeled bottles for haematological and serum biochemical (metabolites) analyses. Blood samples for haematological parameters were collected into bottles pretreated with ethylene diamine tetra acetic acid (EDTA) as anti-coagulant. Blood samples for biochemical indices were collected into other sample bottles containing no anti-coagulant. The serum biochemical indices included total protein, globulin, albumin, albumin: globulin ratio, cholesterol and glucose. Packed cell volume (PCV), red blood cell count (RBC), white

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blood cell (WBC) and haemoglobin were determined by Wintrobe's microhaematocrit, improved eubauerhaemocytometer, cyanometaemoglobin and Bausch and Lomb Spectromic-20 (Bausch and Lomb, Inc., Rochester, N.Y) at a wave length of 540 nm was used to determine the hemoglobin values by using a cyanomethemoglobin standard, respectively [13].Mean corpuscular volume (MCV), mean corpuscularhaemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated according to Jain [14].

Statistical analysis

Data obtained were subjected to analysis of variance (ANOVA) using SAS Statistical Package [15]. The means were separated using Duncan multiple range test of the same package.

RESULTS

Composition of experimental diets

The proximate composition, metabolisable energy and anti-nutritional factors in cooked wild cocoyam corm as reported [9] are presented in Table 1. Table 2 shows the gross composition of the experimental diets**.** All ingredients except maize and cooked wild cocoyam [*Colocasia esculenta* (L.) Schott] corms (CWCC) that was substituted for maize were the same for all four diets. The replacement of maize with CWCC is on weight for weight basis.

Performance parameters

The performance indices of hybro broilers fed the experimental diets as recorded in the study are presented in Table 3. Variations obtained in feed intake were not significant ($P > 0.05$). The average weight gain (WG), feed conversion ratio (FCR), cost per kilogramme feed (CPKF) and cost of feed per kilogramme weight gain (CFPKWG) were significantly ($P < 0.05$) affected by dietary treatments. The highest ($P < 0.05$) WG (304.48g/b/wk) was obtained in birds fed the control diet. The least ($P < 0.05$) FCR (2.56) on the other hand was obtained in birds fed 0% CWCC-based diets (control). This significantly ($P < 0.05$) increased to 2.92, 3.12 and 3.24, for birds fed 10, 20 and 30%, CWCC-based diets, respectively. A similar trend was obtained for the cost per kg feed such that the control diet (0% CWCC) was the highest (₦50.01) which significantly ($P<0.05$) decreased to ₦38.42, ₦36.84 and ₦35.26, for diets formulated with 10, 20 and 30% CWCC, respectively. The cost of feed per kg weight gain (₦127.86) obtained in birds on control (0% CWCC-based diets) was significantly (P<0.05) higher than ₦112.19, ₦114.82 and ₦114.36, obtained in birds fed 10,20 and 30% CWCC-based diets, respectively, indicating that birds fed 10% gave the least cost of feed consumed to produce a kg live weight.

Carcass characteristics

Table 4 shows the carcass characteristics including the organ weights of hybro broilers fed the experimental diets. The mean live weight (LW), bled weight (BW), dressed weight (DW), heart weight (HW) and gizzard weight (GW) varied significantly ($P<0.05$) across the dietary treatments. Results of the study revealed that LWand DW reduced as dietary inclusion level of CWCC increased. The highest ($P<0.05$) DW

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(64.78%) was obtained in birds fed 0% CWCC (control). This decreased (*P<0.05*) to 62.93, 61.01 and 60.57%, respectively for birds fed 10, 20 and 30% CWCC-based diets. There was numerical increase (*P > 0.05*) of the gastro-intestinal tract and corresponding decrease (*P > 0.05*) of the abdominal fat with increased inclusion level of CWCC in the diets. Variations obtained in the heart weight (HW) did not follow any definite trend that could be attributed to dietary treatments.

Serum metabolites and blood chemistry
Results of the serum metabolites investigations (Table 5) showed that only albumin: globulin ratio and cholesterol were significantly (*P<0.05*) affected by dietary treatments. Albumin: globulin ratio values were 0.60, 0.49, 0.49 and 0.52, respectively for birds fed control, 10, 20 and 30% CWCC-based diets. The highest (*P<0.05*) cholesterol (134.54mg/dl) obtained from the birds fed control diet reduced (*P<0.05*) to 132.80, 125.48 and 121.91mg/dl, respectively for birds fed 10,20 and 30% CWCC-based diets. Variations in the values of total protein (6.28± 0.49g/dl), albumin (2.15± 0.17g/dl), globulin (4.13± 0.33g/dl) and glucose (129.96± 3.10mg/dl) for broilers on control and CWCC-based diets were not significant (*P>0.05*). Results of the blood chemistry evaluation of broiler finishers as affected by contents of anti-nutritional factors in CWCC arepresented in Table 6. All the haematological parameters were not different (*P > 0.05*) among the dietary treatments.

DISCUSSION

The determined nutrients composition reflected the variability in the original contents of maize and CWCC which were the variable ingredients. The CP, CF and ME of all the diets met the literature recommended values for birds raised in tropical environments [16].

The non-significant variation in feed intake across the dietary treatments was a result of minimal anti-nutritional factors (ANFs) in CWCC due to processing. The slight numerical (*P > 0.05*) increases in this parameter with CWCC could be linked to synergetic effects of minimal increases in anti-nutrients and CF, and decreased ME with increased CWCC in the diets. Birds are known to eat primarily to satisfy their energy requirements [17, 18, 19]. An earlier study [20] showed that inclusion of fibrous material in a feeding trial had an energy dilution effect on feed thereby increasing the feed intake. It is expected that increase in feed intake will normally result in increased body weight gain [17]. However, the increase in feed intake as level of substitution increased did not bring along with it corresponding weight gain. The FCR also increased with contents of CWCC in the diets. This may be ascribed to the contents of residual ANFs in CWCC. Contents of residual ANFs detected in CWCC could be responsible for the depression in the WG and elevated FCR. These ANFs have been found to impair digestion, absorption and utilization of nutrients [21, 22, 23]. Lower cost per kilogramme feed formulated on 10-30% CWCC recorded in this study than the control may suggest the suitability of CWCC as a cheaper alternative to maize. Similar reduced costs per kilogramme feed formulated with alternative unconventional feed ingredients have been reported [24]. Despite the lower WG and higher FCR of the birds fed with 10-30% CWCC-based diets than the control, the lower cost of the former (10-

30% CWCC based diets) still produced cheaper cost of a kilogramme WG. This agrees with the findings [23] that total feed cost decreased with increasing inclusion level of alternative unconventional feed ingredients in the diets of growing rabbits. Total feed cost reduced by 12.26, 10.20 and 10.56% respectively at 10, 20 and 30% levels of substitution of CWCC for maize in the diets. Mortality value was the same across all dietary treatments.

The higher dressed weight (DW) of the control than other CWCC-based diets may indicate better conversion of feed to edible meat by the birds fed the control diet. Results obtained for the heart weight (HW) agreed with the submission that the enlargement of the heart muscle was not a consistent change in birds fed Velvet beans [25]. Higher GW of birds fed CWCC-based diets than the control may reflect the extra muscular work required to process these former diets which were relatively higher in fibre and contained ANFs. The GW has been linked to the type of diets consumed especially high fibre particle [26].The values of glucose obtained in all treatments were similar to the control, the total protein (5.20-6.90 g/dl) and albumin (2.10-3.45g/dl) fell within the recommended for normal chickens [13]. Diets with lower calorieshave been recommended for birds in the tropics than recommended for those in temperate regions [16, 26]. The non-significant values of the total protein, albumin, globulin and glucose may also indicate adequacy of nutrients for the experimental birds. Reduced packed cell volume, haemoglobin and total protein have been linked to low levels of nutrients in feeds [27].That the birds fed the control diet had the highest cholesterol and subsequent reductions in serum levels of this parameter with increased inclusion level of CWCC may be linked to contents of saponins in the CWCC-based diets. Similar findings of reduced plasma cholesterol concentrations with saponins have been reported [28, 29]. The values of RBC, WBC, PCV and Hb fell within 1.58-3.82 mm^3x 10^6, 9.20-28.60 mm^3x 10^3, 24.90-40.70% and 7.40-12.2g/dl, respectively recommended for normal chickens [13]. Low values of blood chemical parameters especially PCV and RBC, an anaemic condition recorded in scavenging Nigerian indigenous chicken was attributed to poor nutrition [30].

CONCLUSION

Maize could economically be replaced by 30% cooked wild cocoyam [*Colocasia esculenta* (L.) Schott] corm in the diets of broiler finishers with no deleterious effects on the health of the birds. The ability of CWCC to reduce the serum cholesterol is an added nutritional importance in its favour and could be a likely panacea or solution to the problem of health scare normally associated with the consumption of poultry meat. Although the cost of feed per kg live weight of birds fed 10, 20 and 30% CWCC-based diets are lower or cheaper than the control (0% CWCC), the lowest cost of feed per kilogramme live weight gain (₦112.19) is obtained for birds fed 10% CWCC-based diets; 10% level of substitution can therefore be recommended for optimum profitability.

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Table 1: Proximate composition, metabolisable energy and anti-nutritional factors in cooked wild cocoyam

Parameters	Cooked wild cocoyam corms
Dry Matter (%)	88.64
Crude Protein (%)	6.13
Crude Fibre (%)	3.55
Ether Extract (%)	0.75
Ash (%)	2.76
Nitrogen Free Extract (%)	75.45
Metabolisable Energy (Kcal/kg DM)	2966.64
Anti-nutrients	
Condensed tannins (g/100g DM)	0.22
Hydrolysable tannins (g/100g DM)	0.05
Phytate (g/100g DM)	0.26
Hydrocyanide (mg/kg DM)	7.30
Saponin (g/100g DM)	0.16
Oxalate (g/100g DM)	0.26

Source: [9]

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Table 2: Gross composition of experimental finisher diets (%)

Ingredients	Diet 1 (0% CWCC)	Diet 2 (10% CWCC)	Diet 3 (20% CWCC)	Diet 4 (30% CWCC)
Maize	50.00	45.00	40.00	35.00
CWCC	0.00	5.00	10.00	15.00
Palm Kernel Cake	8.50	8.50	8.50	8.50
Wheat offal	12.50	12.50	12.50	12.50
Groundnut Cake	10.00	10.00	10.00	10.00
Soy bean Meal	12.00	12.00	12.00	12.00
Palm Oil	0.40	0.40	0.40	0.40
Fish Meal (72% CP)	3.00	3.00	3.00	3.00
Bone Meal	1.50	1.50	1.50	1.50
Oyster Shell	1.35	1.35	1.35	1.35
Salt	0.20	0.20	0.20	0.20
Premix*	0.25	0.25	0.25	0.25
Methionine	0.15	0.15	0.15	0.15
Lysine	0.15	0.15	0.15	0.15
Total	**100.00**	**100.00**	**100.00**	**100.00**
Determined Nutrient Composition (%)				
Dry Matter	89.54	89.63	89.47	89.54
Crude Protein	20.45	20.34	20.00	19.86
Crude Fibre	4.36	4.55	4.59	4.63
Ash	5.14	5.30	5.46	6.55
Ether Extract	3.87	3.58	3.52	3.43
Nitrogen Free Extract	55.72	55.86	55.90	55.07
ME (kcal/kg DM)	3051.28	3017.28	3012.39	2970.38

**Composition of Premix: 2.5kg of premix contains:*
Retinolacetate (10000000iu), Vit. D3 (2000000iu),Vit. E (15000iu), Vit. B (3000mg), Niacin (15000mg),Vit. B6 (3000mg), Vit. B12 (10mg), Vit. K3 (2000mg), Biotin (20mg), Folic Acid (500mg), Calcium pantothenate (800mg), Chlorine Chloride (250000mg), Manganese (75000mg), Iron (25000mg), Copper (5000mg),Zinc (70000mg), Selenium (150mg),Iodine (1300mg),Magnesium (100mg),Ethoxyquine (500g),BHT (700g)
CWCC: Cooked wild cocoyam corms

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Table 3: Performance characteristics of hybro broiler finishers fed cooked wild cocoyam corms as substitute for maize

Parameters	Diet 1 (0% CWCC)	Diet 2 (10% CWCC)	Diet 3 (20% CWCC)	Diet 4 (30% CWCC)	SEM
Feed intake (g/b/wk)	778.19	761.83	790.50	819.80	19.33
Weight gain (g/b/wk)	304.48[a]	260.87[b]	254.58[c]	253.03[d]	12.17
FCR	2.56[d]	2.92[c]	3.12[b]	3.24[a]	0.15
Cost per kg feed (₦)	50.01[a]	38.42[b]	36.84[c]	35.26[d]	3.04
Cost of feed per kg weight gain (₦)	127.86[a]	112.19[c]	114.82[b]	114.36[b]	4.16
Mortality (%)	3.33	3.33	3.33	3.33	-

CWCC: Cooked wild cocoyam corms
[a,b, c, d]Means in the same row with different superscripts differ significantly ($P < 0.05$)
SEM = Standard error of the mean

Table 4: Carcass characteristics of broilers fed cooked wild cocoyam corm-based diets

Parameters	Diet 1 (0% CWCC)	Diet 2 (10% CWCC)	Diet 3 (20% CWCC)	Diet 4 (30% CWCC)	SEM
Live weight (Kg)	1.97[a]	1.72[b]	1.65[c]	1.63[d]	0.09
Bled weight (%)	96.94[ab]	97.80[a]	95.80[bc]	95.10[c]	0.65
Plucked weight (%)	88.43	83.33	82.97	90.78	2.50
Eviscerated weight (%)	72.91	71.98	69.56	69.79	1.93
Dressed weight (%)	64.78[a]	62.93[ab]	61.01[b]	60.57[b]	1.90
Gastro intestinal tract (%)	9.19	10.30	10.33	10.82	0.53
Abdominal fat (%)	2.03	1.81	1.68	1.48	0.21
Organ weight (% of carcass)					
Kidney	0.96	1.20	1.27	1.23	0.15
Lungs	0.87	0.92	0.82	0.91	0.08
Heart	0.56[d]	0.71[b]	0.84[a]	0.62[c]	0.08
Liver	3.35	3.60	3.95	3.96	0.37
Gizzard	2.75[d]	3.56[c]	3.57[b]	3.59[a]	0.24

CWCC: Cooked wild cocoyam corms

[a,ab, bc, d]Means in the same row with different superscripts differ significantly ($P < 0.05$)

SEM = Standard error of the mean

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Table 5: Serum metabolites of broilers fed cooked wild cocoyam corm-based diets

Parameters	Diet 1 (0% CWCC)	Diet 2 (10% CWCC)	Diet 3 (20% CWCC)	Diet 4 (30% CWCC)	SEM
Total protein (g/dl)	6.13	6.03	6.18	6.77	0.27
Albumin (g/dl)	2.29	1.98	2.02	2.32	0.12
Globulin (g/dl)	3.83	4.05	4.16	4.46	0.19
Albumin: Globulin ratio	0.60[a]	0.49[ab]	0.49[ab]	0.52[b]	0.03
Cholesterol (mg/dl)	134.54[a]	132.80[ab]	125.48[ab]	121.91[b]	3.85
Glucose (mg/dl)	133.06	129.37	127.13	130.29	3.83

CWCC: Cooked wild cocoyam corms
[a,ab]Means in the same row with different superscripts differ significantly (*$P < 0.05$*)
SEM = Standard error of the mean

Table 6: Haematology of broilers fed cooked wild cocoyam corm-based diets

Parameters	Diet 1 (0% CWCC)	Diet 2 (10% CWCC)	Diet 3 (20% CWCC)	Diet 4 (30% CWCC)	SEM
Red Blood Cells ($mm^3 \times 10^6$)	3.12	3.32	3.35	3.32	0.18
White Blood Cells ($mm^3 \times 10^3$)	19.55	19.75	20.28	20.32	1.54
Packed Cell Volume (%)	27.67	27.67	28.00	27.67	0.49
Haemoglobin (g/100ml)	9.27	9.47	9.37	9.23	0.16
Corpuscular Volume (µ)	91.15	83.69	84.86	83.62	5.96
Corpuscular Haemoglobin Concentration (%)	33.49	34.26	33.45	33.38	0.46
Corpuscular Haemoglobin (µ µg)	30.54	28.61	28.39	27.87	1.93

CWCC: Cooked wild cocoyam corms
SEM = Standard error of the mean

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