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Assessing the potential of cassava as wheat substitute for economic meat production in White Pekin ducks

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ABSTRACT

This research was completed on 240-day-old White Pekin ducklings to conclude the potential of cassava (*Manihot esculenta*) tubers as a cost-effective alternative to wheat in duck diets and to assess its impact on the effectiveness of the feed, meat production, and carcass quality of the ducklings. The ducklings were allotted randomly into three groups; each fed by one of the formulated experimental diets up to a time of eight weeks: control diet with no cassava (Cassava-0), and two experimental diets replacing 50% (Cassava-50) or 100% (Cassava-100) of the wheat. All three new diets were iso-nitrogenous (21.79-22.41% CP) and iso-caloric (2866-2889 kcal ME/kg). No significant difference in body weight was observed among the groups (2290.39-2338.83 g), and the daily feed intake (DFI) in the Cassava-100 group (127.59 g) was comparable to that in the Cassava-0 (126.69 g) and Cassava-50 (136.04 g) groups. The cumulative feed intake was comparable between the Cassava-100 (5548.01 kg) and Cassava-0 (5573.61 kg) groups but was lower than that of the Cassava-50 group (5689.30 kg). The 8th week cumulative FCR in the Cassava-100 group (2.37) was significantly lower than that in the Cassava-50 group (2.48) but was comparable to that of the Cassava-0 group (2.44). Furthermore, the feed intake and nutrient metabolisability remained consistent between both levels of wheat replacement (cassava -50 and cassava 100). The eviscerated weight at 6th week (range 62.43 to 65.21%) and 8th week (64.98 to 65.85) and the primal cut-up parts viz. neck, legs, breast, back and wings did not vary significantly across the groups Among the three experimental feeds, Cassava-100 (Rs. 31.56/kg) was the most economical, followed by Cassava-50 (Rs. 31.95/kg) and Cassava-0 (Rs. 32.50/kg) was the most expensive one, suggesting that wheat can fully be an economically viable alternative to cassava tubers in White Pekin duck diets for meat production for up to eight weeks

Keywords: Cassava, Ducks, Meat, Metabolisability, Tubers, Wheat, White Pekin

Duck represents only a small percentage (3.98%) of the total poultry masses in India, but exhibited a substantial population growth surpassing that of the fowl (42.36% vs 16.64%) in the last livestock census (Anonymous 2019). This reflects the growing demand of duck farming in the country. Besides, due to suitability for backyard and integrated farming, survivability in moist land, hardiness of the ducks to several poultry diseases etc. the duck husbandry is gaining popularity among the famers (Naik *et al.* 2022). However, the rising feed costs and limited availability of conventional energy sources especially the wheat have fuelled up the feed-food competition necessitating incorporation of alternative energy sources in duck feed. Normally, wheat is the main cereal used in duck feed as energy source; however, the increase in its cost is becoming a major constraint and the farmers are looking for a locally available suitable alternative for wheat (Naik *et al.* 2023). Cassava (*Manihot esculenta*) is a widely cultivated root crops in tropical conditions and is generally grown for its tubers due to its high energy value (Coursey and Hayens 1971, Ravindran and Blare 1991, Garcia and Dale 1999). Cassava has the highest carbohydrate content amongst all staple crops and gaining popularity as an important feed component of poultry diets (Morgan and Choct 2016). Owing to its elevated carbohydrate material; cassava tubers can be well utilized as energy source in duck feed. Raising White Pekin ducks is possible in rustic regions with addition of the locally available cassava tubers for meat purpose (Sahoo *et al.* 2014). However, only few literatures are available on replacement of wheat with cassava in White Pekin ducks for meat purpose. Therefore, the present study aimed to consider the efficacy of cassava tubers (*Manihot esculenta Crantz, Euphorbiaceae*) as replacement of wheat in the diets of White Pekin ducks assessing the economic viability of the replacement.

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MATERIALS AND METHODS

White Pekin ducklings (day old, 240) were allotted

randomly into three groups; each one has four replicates and every replicate has 20 ducklings. The collected cassava tubers were peeled, sliced, sundried and ground before using as feed ingredient. Three experimental diets without (Cassava-0) and with Cassava replacing wheat at 50% (Cassava-50) and 100% (Cassava-100) levels were prepared (Table 1). Throughout the experiment, the birds were reared on deep litter system and the three experimental diets were provided at random to the different groups *ad lib.* following standard nutrient requirements (Singh and Panda 1996) and managemental practice. Metabolic trial with four days collection time was performed on six ducklings from every group i.e. two birds per replicate, in separate cages. Feed intake and live weight were recorded on daily and weekly basis, respectively. The feed conversion ratio (FCR) was calculated as unit feed consumed per unit body weight gain. Proximate analysis was made for feeds, residues and faecal samples as per AOAC (2005). After six weeks and eight weeks, one duck from every replicate (four birds from every group) were used for the study of carcass characteristics following standard procedures. This study used a Completely Randomized Design (CRD). Statistical analysis of the data involved ANOVA- a one-way analysis of variance (Snedecor and Cochran 1994), subsequently Duncan's multiple range test (Duncan 1955) was used to the compare means, with significance level set at threshold of $p<0.05$.

Table 1. Physical and chemical compositions of different diets

Feed ingredient	Diet#		
	Cassava-0	Cassava-50	Cassava-100
Physical compositions (kg/ 100 kg)			
Wheat (Kg)	60	45	30
Cassava (Kg)	0	15	30
Soybean (Kg)	23	27	31
Fishmeal (Kg)	07	07	07
DORB (Kg)	08	04	0
Oyster shell (Kg)	01	01	01
DCP (Kg)	01	01	01
Sunflower oil (Kg)	01	01	01
Trace minerals## (g)	100	100	100
DL-methionine (g)	50	50	50
Lysine (g)	50	50	50
Vit. AD B K (g)	20	20	20
Vit E &^{3}Sé (g)	20	20	20
Vit B Complex (g)	20	20	20
Toxin binder (g)	100	100	100
Choline chloride (g)	100	100	100
Chemical composition (on % DM basis)			
Organic Matter	89.46	89.39	89.44
Crude Protein	22.41	21.84	21.79
Ether Extract	2.65	2.13	2.59
Crude Fibre	66.02	71.47	72.61
NFE			
Calculated value			
Energy (ME, kcal/kg)	2889	2878	2866
Lysine (%)	1.25	1.37	1.48
Methionine (%)	0.47	0.46	0.45
Ca (%)	1.34	1.33	1.33
Total P (%)	0.93	0.87	0.81
Economics			
Cost of feed (Rs./kg)	32.50	31.95	31.56

Cassava-0: Diets without cassava, Cassava-50: Diets with cassava replacing 50% wheat, Cassava-100: Diets with cassava replacing 100% wheat, ## Trace mineral contained Mn 11 g, Zn 10 g, Cu 2g, Fe 11 g, Se 0.15 g, I 0.25 g, Co 0.125 g and Cr 40 mg per 100 kg feed

RESULTS AND DISCUSSION

All the diets were iso-nitrogenous (21.79-22.41% CP) and iso-caloric (2866-2889 kcal ME/ kg) (Table 1). The body weight (49.06-49.33 g) of the day-old ducklings was similar among the groups. At 6 weeks also, the ducks attained similar body weight of 1822.27-1867.13 g in all the groups (Table 2). Similarly, there was no significant difference in the 8th week body weight of the ducks among the groups (2290.39-2338.83, g). Sahoo *et al.* (2014) reported similar 6th week body weight (1832-2010 g) in White Pekin ducklings experimentally fed with Cassava tuber meal replacing maize by 40% and 60% and there was significant increase body weight of ducklings fed with soaked cassava meal@40% and 60% replacement of maize in diet. The 6th week body weight of the White Pekin ducks in our study was lower than the body weight (3023 g) recorded by Farhat and Chavez (2000) and higher than that recorded by Bhuyian *et al.* (2005). In contrast to this study, several researchers have reported a higher 8th week body weight in Pekin ducks (Solomon *et al.* 2006, Solomon *et al.* 2007, Kuzniacka and Adamski 2019); lower body weight (Rabbani *et al.* 2019, Ghosh *et al.* 2022).

The daily feed intake (DM basis) of the ducks in 1st week (23.29-25.39 g) and 6th week (129.54-131.56 g) was comparable amongst the three experimental groups (Fig. 1). However, in 8th week, the daily feed intake per duck in Cassava-0 group (126.69 g) and Cassava-100 group (127.59 g) were similar and higher ($p<0.05$) than Cassava-50 group (136.04 g). Similarly, up to 1st week (163.01-177.70 g) and 6th week (3777.08-3802.68 g), the cumulative feed intake was similar among the groups (Fig. 2). However, up to 8th weeks although the cumulative feed intake in Cassava-50 groups (5689.30 g) was slightly higher than the Cassava-100 group (5548.01g), both were comparable to Cassava-0 group (5573.61g). Our finding is being supported by the Khaleed *et al.* (2018) who recorded non-significant effect of cassava starch extraction residue meal on feed intake of Cherry Valley ducklings. Our results also align with findings of Lei *et al.* (2019), who likewise noted non-significant differences in both average daily weight gain and daily feed intake of Cherry Valley ducklings fed with different levels of fermented cassava bio-ethanol wastes diets containing varying amounts of fermented cassava bio-ethanol wastes. Birds often regulate their feed intake to match the energy need (Onifade and

Table 2. Effect on weekly body weight (g) and feed conversion

Age (weeks)	Diet#		
	Cassava-0	Cassava-50	Cassava-100
	Weekly body weight (g)		
Day Old	49.06±0.41	49.17±0.50	49.33±0.17
1st week	151.98±3.48	150.54±2.44	145.77±9.06
2nd week	420.79±10.50	439.73±15.56	404.96±21.84
3rd week	718.96±13.96	755.34±27.31	703.46±8.52
4th week	1103.90±18.94^{b}	1062.94±16.06^{ab}	1011.23±19.33^{a}
5th week	1578.52±8.16^{b}	1507.60±28.21^{a}	1492.69±9.98^{a}
6th week	1865.67±47.28	1867.13±48.24	1822.27±20.59
7th week	2091.52±18.61	2100.39±36.39	2116.61±13.50
8th week	2290.39±22.95	2292.80±24.87	2338.83±10.45
	Feed conversion		
Up to 1st week	1.07±0.05	1.13±0.05	1.23±0.09
Up to 2nd week	1.38±0.03	1.40±0.05	1.52±0.08
Up to 3rd week	1.72±0.02	1.60±0.09	1.68±0.04
Up to 4th week	1.85±0.03	1.88±0.06	1.94±0.07
Up to 5th week	1.82±0.01	1.92±0.07	1.93±0.05
Up to 6th week	2.03±0.06	2.04±0.07	2.08±0.02
Up to 7th week	2.24±0.02	2.26±0.06	2.20±0.02
Up to 8th week	2.44±0.03^{ab}	2.48±0.03^{b}	2.37±0.01^{a}

Cassava-0: Diets without cassava, Cassava-50: Diets with cassava replacing 50% wheat, Cassava-100: Diets with cassava replacing 100% wheat

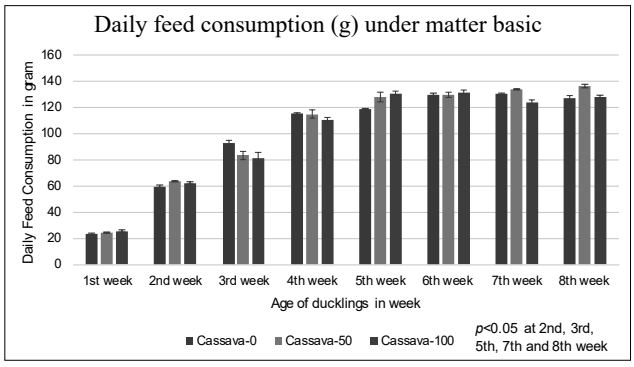

Fig. 1. Daily feed intake (g) of White Pekin ducklings fed with # Cassava-0: Diets without cassava, Cassava-50: Diets with cassava replacing 50% wheat, Cassava-100: Diets with cassava replacing 100% wheat

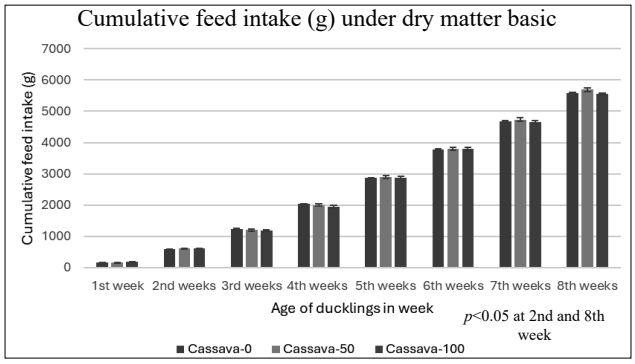

Fig. 2. Cumulative feed intake (g) of White Pekin ducklings fed with # Cassava-0: Diets without cassava, Cassava-50: Diets with cassava replacing 50% wheat, Cassava-100: Diets with cassava replacing 100% wheat

Tewe 1993). In our study, attempt was made to formulate balanced feeds being iso-energetic and iso-nitrogenic which may be the reason behind non-significant effect of the cassava root meal inclusion level on feed intake of the ducklings.

All the groups exhibited consistent feed conversion ratio (2.03-2.08) calculated as kg feed consumed per kg weight gain up to 6th week (Table 2). The 8th week cumulative FCR in Cassava-100 group (2.37) was significantly lower (p<0.05) than Cassava-50 group (2.48) but comparable to Cassava-0 group (2.44). Sahoo *et al.* (2014) observed higher FCR (up to 6 week) of 2.28 and 2.32 in White Pekin ducklings fed with diet replacing 40% and 60% of maize by water-soaked cassava tuber meal, respectively and FCR of 2.56 and 2.57 in ducklings fed with diet replacing maize by raw cassava @ 40 and 60%, respectively. Khaleed *et al.* 2018 found no adverse effect of cassava residue meal on FCR and growth rate of growing Cherry Valley ducklings. Bhuyian *et al.* (2005) recorded a FCR of 2.46 at 6th week in Pekin ducks. Rabbani *et al.* (2019) and Ghosh *et al.* (2022) recorded a higher 8th week FCR in White Pekin ducks.

Feeding of cassava had no effect on the feed intake (132.07-139.23 g) and metabolisability of dry matter (72.64-73.16%), organic matter (73.62-74.46%), crude protein (75.90-77.06%), ether extract (78.12-80.39%), crude fibre (66.02-67.19, %) and nitrogen free extract (72.98-73.72, %) of the ducks both at 50% and 100% level of replacement of wheat (Table 3). The nitrogen intake (g/d) in Cassava-50 group (4.85) was lower than Cassava-0 group (5.34); but both were similar to Cassava-100 group (4.98). However, there was no significant difference in the nitrogen outgo (1.17-1.22, g/d) among the groups. Although, the nitrogen balance (g/d) in Cassava-50 group (3.69) was lower than

Table 3. Effect on metabolisability of various nutrients and nitrogen balances

Parameter	Diet#		
	Cassava-0	Cassava-50	Cassava-100
Dry matter Intake (g/d)	139.23±2.04	132.07±4.23	136.47±4.33
Metabolisability (%) of nutrient			
Dry matter	73.16±0.70	72.89±0.98	72.64±1.30
Organic matter	74.46±0.65	73.66±0.94	73.62±1.22
Crude protein	77.06±0.60	75.90±0.87	76.00±1.04
Ether extract	80.39±1.47	78.12±2.45	79.84±1.71
Crude fibre	66.02±1.10	66.80±1.40	67.19±2.22
Nitrogen free extract	73.72±0.65	73.23±0.96	72.98±1.27
Nitrogen balances			
Nitrogen intake (g/d)*	5.34±0.07^{b}	4.85±0.14^{a}	4.98±0.14^{ab}
Nitrogen out go (g/d)*	1.22±0.02	1.17±0.04	1.19±0.03
Nitrogen balance (g/d)*	4.11±0.08^{b}	3.69±0.13^{a}	3.79±0.15^{ab}
Nitrogen balance as % of nitrogen intake	77.06±0.60	75.91±0.87	76.32±1.04

Cassava-0: Diets without cassava, Cassava-50: Diets with cassava replacing 50% wheat, Cassava-100: Diets with cassava replacing 100% wheat,* Means bearing different superscripts in a row differ significantly ($p<0.05$).

the Cassava-0 group (4.11), but both were comparable to Cassava-100 group (3.79); however, the nitrogen balance as percentage of nitrogen intake (75.91-77.06) was similar among the groups. Our findings of the non-significant effect of cassava on nitrogen balance and metabolizability of nutrients agree with the findings of Sahoo *et al.* (2014) in White Pekin ducklings and Bhuyian *et al.* (2005) in broilers. Sahoo *et al.* (2014) reported marginally higher nitrogen retention in White Pekin ducks fed with water soaked and raw cassava tuber meals. However, Sandi *et al.* (2018) recorded a declining tendency in metabolizable energy and nitrogen retention along with the improved level of silage-based cassava meal in the diet of ducks. Furthermore, inclusion of silage-based cassava diets up to a level of 75% did not exhibit any significant difference in the parameters compared to the control diet. Nitrogen excretion for all the experimental groups was below the nitrogen consumption, signifying a positive nitrogen retention in the ducks under study. This outcome further indicates that the nitrogen intake surpassed the animal's essential requirements, the surplus being accumulated and subsequently utilized by the animals for their physiological

Table 4. Carcass characteristics at six weeks

Parameter	Diet#		
	Cassava-0	Cassava-50	Cassava-100
Body weight (g)	1864.25±40.33	1791.51±74.33	1849.00±72.23
Body parts as percentage of body weight			
Blood	5.46±0.27^{a}	4.71±0.27^{a}	6.47±0.25^{b}
Feather	7.30±0.82	8.56±0.24	8.05±0.59
Head	7.57±0.17	7.55±0.16	7.74±0.45
Shank	4.09±0.15	3.85±0.09	3.98±0.16
Heart	0.57±0.04	0.49±0.00	0.49±0.04
Liver	2.01±0.00	1.94±0.00	2.33±0.00
Gizzard	3.18±0.03	3.24±0.08	3.15±0.03
Giblet (heart+liver+gizzard)	5.76±0.06	5.68±0.13	5.98±0.18
Intestine	3.60±0.10	3.46±0.16	3.75±0.10
Eviscerated weight	65.21±0.78	65.12±0.32	62.43±0.88
Cut off parts as percentage of eviscerated weight			
Neck	9.86±1.01	10.24±0.49	10.15±0.32
Legs	26.22±1.34	26.41±0.49	26.30±0.67
Breast	21.99±0.84	20.70±0.43	19.64±0.88
Back	14.96±1.73	14.76±0.43	14.64±0.52
Wings	15.06±0.87	16.38±0.18	16.64±0.50
Processing loss (%)	0.20±0.02	0.15±0.09	0.16±0.03

Cassava-0: Diets without cassava, Cassava-50: Diets with cassava replacing 50% wheat, Cassava-100: Diets with cassava replacing 100% wheat

Table 5. Carcass characteristics at eight weeks

Parameter	Group		
	Cassava-0	Cassava-50	Cassava-100
Body weight (g)	2255.0±133.35	2217.00±93.90	2263.25±89.81
Body parts as percentage of body weight			
Blood	5.92±0.31	5.98±0.22	5.87±0.21
Feather	10.71±0.89	10.54±1.79	11.38±0.77
Head	5.67±0.14	5.71±0.19	5.86±0.18
Shank	3.56±0.16	3.08±0.07	3.05±0.09
Heart	0.501±0.03	0.50±0.03	0.52±0.02
Liver	1.67±0.06	1.56±0.09	1.80±0.14
Gizzard	2.88±0.09	2.99±0.10	3.03±0.07
Giblet (heart+liver+gizzard)	5.06±0.16	5.02±0.19	5.33±0.18
Intestine	3.15±0.07[b]	3.13±0.11[b]	2.83±0.05[a]
Eviscerated weight	65.56±0.36	65.85±1.66	64.98±0.68
Cut off parts as percentage of eviscerated weight			
Neck	9.95±0.37	10.98±0.70	11.47±0.38
Legs	22.35±0.93	22.72±0.54	22.76±0.11
Breast	26.12±1.44	26.47±0.77	24.32±0.58
Back	23.83±0.47	24.16±0.49	24.78±0.63
Wings	16.35±0.45	15.39±0.79	15.04±0.48
Processing loss (%)	1.42±0.08	1.40±0.48	1.64±0.49

Cassava-0: Diets without cassava, Cassava-50: Diets with cassava replacing 50% wheat, Cassava-100: Diets with cassava replacing 100% wheat

maintenance and production (Maynard and Loosely 1962).

Cassava-0 feed (Rs. 32.50/-per kg) was costlier followed by Cassava-50 feed (Rs. 31.95/- per kg) and Cassava-100 feed (Rs. 31.56/-per kg), which depicts the cheaper cost of cassava comparison to wheat and the potential use of cassava in duck diet to economize the cost of production.

The slaughter body weight of the ducks at six weeks (1791.51-1864.25, g) was similar among the groups (Table 4). Except blood, the other body parts *viz.* feather (7.30-8.56), head (7.55-7.74), shank (3.85-4.09), heart (0.49-0.57), liver (1.94-2.33), gizzard (3.15-3.24), giblet (5.68-5.98), intestine (3.46-3.75) were consistent as percentage of body weight across the three groups. The eviscerated carcass weight percentage ranged from 62.43 to 65.21 and was similar among the groups. Further, the various cut off parts *viz.* neck (9.86-10.24), legs (26.22-26.41), breast (19.64-21.99), back (14.64-14.96) and wings (15.06-16.64) were similar among the groups. Similarly, Khaleed *et al.* (2018) have reported that dietary inclusion of cassava residue meal in the diet of Cherry Valley ducklings up to 150 g/kg feed, exhibited non-significant effects on duck growth parameters, dressed weight, internal organs. Olayemi *et al.* (2018) observed a lower dressing percentage (50-57%) in 6-week-old Mallard ducklings fed with fermented cassava root tuber-leaf meal; however, a declining trend in dressing percentage was observed with increased level of cassava in the diet. The effect of cassava root tuber meal was non-significant on the dressing percentage and primal cuts.

The slaughter body weight of the ducks at eight weeks (2217.00-2263.25 g) was similar among the groups (Table 5). The body parts *viz.* blood (5.87-5.98), feather (10.54-11.38), head (5.67-5.86), shank (3.05-3.56), heart (0.50-0.52), liver (1.56-1.80), gizzard (2.88-3.03), giblet (5.02-5.33) as percentage of body weight were similar among the groups. The intestine as percentage of body weight was similar in Cassava-0 group (3.02) and Cassava-50 group (3.01) and higher than the Cassava-100 group (2.83). Further, the various cut off parts *viz.* neck (9.95-11.47), legs (22.35-22.76), breast (24.32-26.47), back (23.83-24.78) and wings (15.04-15.39) were similar among the groups. Eviscerated weight as % of body weight (64.98-65.85) was similar among the groups and was higher than the reports of Ghosh *et al.* (2022). Non-significant effect of cassava root meal on eviscerated carcass weight of White Pekin duckling was observed by Sahoo *et al.* (2014). In another study, Lei *et al.* (2019) observed non-significant differences in carcass yield, eviscerated carcass yield of Cherry Valley ducks fed different levels of fermented cassava bio-ethanol wastes. In contrast to the present findings, earlier workers like Sahoo *et al.* (2014) and Steczny *et al.* (2017) have observed a higher eviscerated weight % of White Pekin ducklings. In another study Saree *et al.* (2017) observed that Cassava based diet influenced more weight gain and better carcass characteristics in meat type ducks during the finisher stage of ducklings (35-42 days old) than the corn-based diet which is also depicted in our study better in terms of better primal cuts in ducklings fed with cassava-based diet.

The outcomes of this study concluded that cassava root tubers can be used as potential energy source in the diet of White Pekin ducklings reared for meat purpose. Wheat can be replaced by Cassava tuber meal at 100% level up to eight weeks in the diet of White Pekin ducks to economize

the feed formulation and meat production without any adverse effect on growth rate, FCR, feed intake, dressing percentage and primal cuts yield.

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