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Carcass characteristics and meat quality of crossbred pigs fed on different levels of tapioca (*Manihot esculenta*) root meal

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Cassava or tapioca (*Manihot esculenta*) is grown mostly by farmers throughout the Nagaland. The tapioca root meal is high in soluble carbohydrate and low in protein and fibre (Dominguez 1990). Tapioca root meal is used for the feeding of pig and the level of hydrocyanic acid (HCN) in cassava which limits its use is considerably eliminated by chopping and sun-drying thereby rendering it completely safe for livestock feeding (Tewe *et al*. 1980). Considering the abundant availability of tapioca root in this state and high concentration of soluble carbohydrates, an experiment was conducted on growing pigs fed on processed tapioca root meal as energy source replacing maize.

Growing crossbred pigs (24) of about 2 months of age were distributed into 3 groups of 8 animals each in a randomized block design. One group of animals were fed on maize based diet (0MR) as per BIS (1986) whereas other 2 groups of animals (25MR and 50MR) were fed on diet replacing maize with tapioca root meal at 25 and 50 percentages respectively. The composition of experimental ration is given in Table 1. Three types of diets were iso-nitrogenous and isocaloric. The animals were fed *ad lib.* and clean water was provided all the times throughout the experiment.

Growth performance: Animals were weighed at weekly interval in the morning before feeding and watering and average daily gain for each animal was calculated. The experiment was continued for 12 weeks of age.

Carcass characteristics: After completion of 12 weeks of feeding trial, 3 pigs from each experimental group (0MR, 25MR and 50MR) were slaughtered at the slaughterhouse for study of carcass characteristics and leather quality.

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Table 1. Composition of ration (%) during the experiment

Nutrient (%)	0 MR	25 MR	50 MR
Ground maize	56	42	28
Tapioca root meal	-	14	28
Wheat bran	11	8	5
Groundnut cake	22	23	25
Fish meal	8	10	11
Mineral mix.	2	2	2
Common salt	1	1	1
CP%ME(Kcal/kg)	19.3 3100	19.1 3146	19.0 3208

0 MR, control; 25 MR, 25% maize replacement; 50 MR, 50% maize replacement. Mineral mixture: Nutritive value per 250 g. Vitamin A , 500000 IU; vitamin D_3 , 100000 IU; vitamin E, 80.00 mg; vitamin B_2, 0.30 g; vitamin B_6, 0.10 g; vitamin B_{12}, 1.00 mg; calcium pantothenate , 0.30 g; niacin, 2.00 g; choline chloride, 15.00 g; vitamin K_3 , 0.10 g; calcium, 80.00 g; phosphorus , 5.00 g; manganese , 3.00 g; iodine , 0.10 g; iron, 0.80 g; copper , 0.25 g; cobalt , 0.05 g; selenium , 2.50 g; zinc, 2.00 g.

Animals were transported to the slaughterhouse 1 day prior to slaughter and were given free access to water without any feed. Body weights of animals were recorded on the day of slaughter. The animals were stunned with captive bolt pistol and bled immediately. After complete bleeding, scalding was done at 60 degree for 6 min. The carcass was opened and eviscerated after separation of head by cutting at atlanto-occipital joint (Ziegler 1968). Weight of the carcass and different organs like head, heart, liver, lungs, kidney, spleen, stomach and intestine were recorded. The dressing percentage of carcass was calculated from carcass weight and body weight of fasting animals and expressed in percentage. Carcass length was measured from anterior edge of first rib to anterior point of aitch bone and expressed in cm. The other parameters like back fat thickness (BFT), loin eye area and weight of loin etc. were recorded as per standard procedure (Ziegler 1968).

Organoleptic evaluation: The meat of each animal slaughtered at the end of the experiment, was cooked and

Table 2. Chemical composition of tapioca root meal and maize (% DM basis)

Feed	DM	CP	EE	CF	NFE	TA
Maize	91.73	10.55	3.80	2.60	81.11	1.94
Tapioca root	94.20	3.30	0.60	2.70	91.10	2.30

DM, Dry matter; CP, crude protein; EE, ether extract; CF, crude fiber; NFE, nitrogen free extract; TA, total ash.

Table 3. Growth performance of crossbred pigs during different phases of experiment

Weeks	0 MR	25 MR	50 MR
	Average daily gain (ADG, g/d)		
0–8	309 [a]	342 [ab]	367 [b]
9–12	424[a]	457 [ab]	496 [b]
0–12	347 [a]	380 [ab]	410 [b]

0 MR, Control; 25 MR, 25% maize replacement; 50 MR, 50% maize replacement. Means bearing different superscript in a row differ significantly (P<0.05).

then evaluated by 10 member sensory panel on 8 point scale (Keeton 1983). Different parameters like colour, flavor, juiceness, texture, tenderness and overall palatability of the cooked meat was judged by the test panel and then statistically analysed for each parameter for evaluation of meat quality.

Statistical analysis: The data of the experiment were statistically analyzed by using computer software.

Chemical composition of tapioca root meal: The chemical composition of maize and tapioca root meal is presented in Table 2. The crude protein content of tapioca root meal was less (Muller *et al*. 1974, Dominquez 1985 and Wu 1991) whereas the crude fibre (CF) content was more than the ground maize (Muller *et al.* 1974). The ether extract content of the tapioca root was poor similar to the findings of others (Muller *et al*. 1974, Wu 1991). Tapioca root meal analyzed in this study contained rich source of NFE which is in agreement with those of Muller *et al*. (1972) and Dominquez (1985). The energy content (ME) of tapioca root in pig was somewhat similar as maize (Muller 1974, FAO 2004, Wu 1991).

Growth performance: The growth performance of crossbred pigs is presented in Table 3. In the first phase of the experiment (0–8 weeks), the ADG were 309±9.53, 342±36 and 367±10 g whereas in the second phase of the experiment (9–12 weeks) it were 424±9.41, 457±31.25 and 496±15.56 g in groups 0MR, 25MR and 50MR respectively. During the whole experimental feeding period (0–12 weeks), the ADG of crossbred pigs were 347±15.91, 380±29.92 and 410±17.10 g in groups 0MR, 25MR and 50MR respectively. The growth rate of pigs in this experiment is same as the growth rate reported by others (Aumaitre 1969, Wu 1991). Thi Loc (1997) observed 465g average daily gain by feeding cassava root meal in the diet of crossbred pig of Vietnam and the result was almost in the same line as of this experiment.

The growth rate of pigs in 50MR group increased significantly compared to control (0MR) group. This agreement was same as reported by others (Aumaitre 1969, Chou *et al.* 1975 and Wu 1991). Ngoan and Ly (2007) reported that, inclusion of 30% of ensiled cassava root in the diet of crossbred pigs improved the average daily gain of pigs in village condition. This may be because of better utilization of nutrients in the ration containing tapioca root. It is reported that, the starch of tapioca root is better digested in pig compared to maize (Kanto *et al*. 2009). In the present experiment it was observed that, the palatability of the ration was good and animals had better acceptability to the ration containing tapioca root compared to maize. In contrast to this result, few workers did not find any improvement of growth rate by feeding tapioca root meal in the ration of crossbred pigs (Jiménez *et al.* 2005).

Carcass characteristics: The carcass characteristics of crossbred pigs are presented in Table 4. The dressing percentages of the animals in 3 groups were 64.33±0.87, 66.10±0.49 and 70.30±0.62 in groups 0MR, 25MR and 50MR respectively. The dressing percentage was increased significantly in 50MR as compared to control group whereas the dressing percentage of 0MR and 25MR did not differ significantly. Increased dressing percentage in 50MR may be because of increased growth rate and nutrient utilization as observed in the present experiment. Moreover, the high disappearance of cassava in the stomach of pig because of rapid hydrolysis of the starch to glucose by gastric secretions (Kvasnitsky 1951) might have contributed for overall improvement of dressing percentage. In contrast to this finding, Jiménez *et al.* (2005) observed nonsignificant difference of dressing percentage of carcass when fed cassava root meal compared to the conventional diet.

Table 4. Carcass characteristics of crossbred pig during the experiment

Gr.	Carcassweight (kg)	Dressing (%)	Leaf fat (kg)	BFT (cm)	Loin eye area (cm)	Loin (kg)
0MR	26.17±1.74	64.33[a]±0.87	0.22[a±]0.01	2.26±0.14	4.67±0.17	6.45±0.77
25MR	28.67±0.88	66.10[a]±0.49	0.20[a±]0.06	2.37±0.08	5.33±0.17	6.33±0.03
50MR	28.00±0.29	70.30[b]±0.62	0.32[b±]0.02	2.30±0.06	5.17±0.17	6.23±0.06

0 MR, Control; 25 MR, 25% maize replacement; 50 MR, 50% maize replacement. Means bearing different superscript in a row differ significantly (P<0.05).

Table 5. Organ characteristics of crossbred pig during the experiment

Group	Liver (kg)	Kidneys (kg)	Heart (kg)	Lungs (kg)	Spleen (kg)
0 MR	1.13±0.10	0.21±0.03	0.145±0.003	0.36±0.01	0.06±0.005
25 MR	1.18±0.06	0.19±0.02	0.145±0.003	0.41±0.02	0.07±0.002
50 MR	1.25±0.14	0.18±0.01	0.147±0.002	0.36±0.03	0.08±0.008

0 MR, Control; 25 MR, 25% maize replacement; 50 MR, 50% maize replacement. Means bearing different superscript in a row differ significantly (P<0.05).

The leaf fat in 3 groups of animals was 0.22±0.01, 0.20±0.06 and 0.30±0.02 kg in groups 0MR, 25MR and 50MR respectively. The leaf fat in animals of 50MR group was significantly more compared to the animals of control group. There was no significant difference in other parameters like carcass length, back fat thickness, loin eye area and weight of loin, similar to the result of other experiments (Wyllie and Lekule 1980, Jiménez *et al*. 2005, Kanto 2009).

The organ characteristics of crossbred pigs are presented in Table 4. The organs like liver, kidney, heart, lungs, spleen, GI tract etc were separated from each animal and weight of each organ was recorded. As per the result, there was no statistical difference between different groups of the experiment.

Organoleptic evaluation of meat: Organoleptic evaluation of meat in 3 groups of animals i.e. 0MR, 25MR and 50MR is presented in Table 5. Different parameters like colour, flavor, juiceness, texture, tenderness and overall palatability of pork were recorded by a 10 member sensory panel on an 8 point scale after cooking the meat. As per the result of the organoleptic evaluation, no such difference was noticed in the parameters like colour, flavor, juiceness, texture, tenderness and overall palatability of pork in 3 groups of animals. This indicated that the quality of the pork was not reduced even if we replaced the maize with tapioca root meal up to a level of 50 %.

The present experiment showed that, maize may be replaced with tapioca root meal up to a level of 50 % for economizing the pork production in NEH region of India.

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