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Original Research

Carcass Yield and Quality of Pork from Pigs Fed Graded Levels of Fig (*Ficus sur*) Fruits Mixed with Maize Grain

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Abstract

Twenty growing Yorkshire piglets of 27.8±1.4kg (mean ± SD) average initial weight were used to investigate the effect of feeding different proportions of ground *Ficus sur* fruits (FSF) mixed with ground maize grain (MG) on carcass yield and quality attributes. The experiment was conducted in randomized complete block design (RCBD) with four treatments and five replications per treatment. The treatment diets were: 100% FSF and 0%MG represented as (100FSF), 67% FSF and 33% MG (67FSF), 33% FSF and 67% MG (33FSF) and 0% FSF and 100% MG (0FSF). For all treatments protein supplement (NSC+SBM) was given to provide about 18% CP to make the ration isonitrogenous. Except for the slaughter weight, which significantly ($P<0.05$) increased with increase in MG level in the diets, all other carcass measurements and primal cuts did not differ ($P>0.05$) among the treatments. However, lungs ($P=0.012$) and gastro intestinal tract (GIT) ($P=0.001$) among the viscera organs were varied. None of the quality attributes of the pork significantly differed ($P>0.05$) in color, taste, flavor, juiciness, tenderness and texture among the treatments. This indicates that similar quality pork can be produced by feeding FSF as those fed with MG. It is, therefore, concluded that substitution of MG with FSFs in the diets of pigs can result in comparable carcass yield and quality attributes.

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INTRODUCTION

Pigs are monogastric animals with high biological efficiency. The productivity and overall merits of pigs is many folds. High prolificacy/fecundity, short gestation periods (short generation interval), fast growth rates, early maturity, wider appetite; sustaining themselves on poor quality feeds with high feed conversion efficiency are some of the merits reported for pigs in relation to the other livestock classes (Lekule and Kyvsgaard, 2003).

The main purpose of pig production, among others, is for carcass products, porcine and to generate income from the sale of live pigs. Pigs have high dressing percentage that mostly ranges from 69.4 - 80.7% (Ramsay *et al.,* 2001; Tischendorf *et al.,* 2002; Mullan *et al.,* 2009) compared to other livestock species such as sheep (40-47.1%) (Tsehay, 2012; Arsenos *et al.,* 2007; Getnet *et al.,* 2008) and beef (52.9-58.7%) (Esterhuizen *et al.,* 2008; Andrzej, 2010; Belete *et al.,* 2010). Pigs are also reportedly to have superior meat quality (Kyriazakis and Whittemore, 2006; Pond *et al.,* 1991). However, more than ruminant animals, which mostly depend on natural pasture and crop residues, shortage of feed are the main bottle neck in pigs as they mainly rely on grain crops as staple feed.

The availability and cost of cereal source feed is one of the limitations in monogastric animal nutrition including pigs. Their dependence on cereal crops like maize forces them to compete for food with man where most farmers in sub-Saharan Africa, including Ethiopia do not produce surplus grains than needed for family consumption. In such situations, the use of naturally available indigenous feed resources like *Ficus sur* fruits would be very important. *Ficus sur* fruits are widely distributed in different parts of Ethiopia and consumed freely by all classes of livestock regardless of the species difference. It contains about 14.5% crude fiber, 5.7% ether extract and 65.3% nitrogen free extract components (Diriba *et al.,* 2014). Moreover, it has very attractive flavor that animals sniff up to a distance of 30 to 50 meters and most of the fruits have sweet taste that human beings also consume.

However, the nutritional merit of the fruits as livestock feed, particularly for pigs' was not studied yet. There was no feeding experiment conducted to address the challenges of pig nutrition in the country so far. Thus, this experiment was conducted with the hypothesis that feeding the fruits to growing Yorkshire pigs as source of energy may result in reasonable carcass yield and quality, which is comparable to feeding maize. The main objective of this study is, therefore, to investigate the effect of dried and ground *Ficus sur* fruits as a replacement for maize grain on carcass yield, composition and sensory preference of pigs.

MATERIALS AND METHODS

Study Site

This experiment was conducted at Haramaya University pig production and training center. The University is located at 9°26'N latitude and 42°3'E longitude with altitude about 1980 meters above sea level. The mean annual rainfall of the study area is about 870 mm, which ranges 560-1260 mm, and the mean maximum and minimum temperatures are 23.4°C and 8.25°C, respectively (Haramaya University Meteorological Station unpublished summary report, 2012).

Experimental Animals and their Management

Twenty uniform growing male weaned Yorkshire pigs with initial live weight of 27.8±1.4 kg (mean ±SEM) were selected from Haramaya University pig production and training center for this experiment. All animals were dewormed with *Ivermectin* injection, topically sprayed with *Diazinone* against mange mites and vaccinated against foot and mouth (FMD) disease before commencement of the experiment. The deworming and spraying were continued at three weeks interval until the end of the experiment as necessary. The pigs were housed and handled in individual pen where they could easily access feed and water troughs (Campbell *et al.,* 1983). The health and welfare of the animals was well maintained until the end of the experiment. The experiment lasted 90 days.

Feeding Management

Mature and dry FSFs were collected from different trees in Horro district, western Ethiopia during the dry season (February to April of 2012), packed in sacks and taken to Haramaya University. It was further sun dried at pig production and training center of the University for four days to remove extra moisture for ease of grinding. The sun dried FSFs were ground in an ordinary mill at Haramaya University (HU) dairy farm in similar particles size with that of maize grain, filled with moisture free sacks and stored in dry room for feeding pigs mixed with maize grain (MG), soybean meal (SBM) and noug seed cake (NSC).

Animals were adapted to the diets for 7 days prior to the actual experiment. During the study, the animals were offered measured quantity of the daily ration. As the requirement of the pigs increase with increase in their body weight (Lee *et al.,* 2000; Kim *et al.,* 2000a; Kim *et al.,* 2000b; DeRouchey *et al.,* 2008) the daily diet offer was increased every two weeks based on their average live weight change. The diets were mixed to maintain uniformity of composition among all treatment groups to avoid its biasing effects on the piglets' nutrient intake. Clean tap water was provided *ad libitum* in a separate water trough throughout the experiment. Soybean meal and noug seed cake were used as protein supplement at isonitrogenous level (18% CP).

Treatment and Design of Experiment

The experiment was laid out in a randomized complete block design with 4 treatments and 5 replications. Dietary treatments were composed of dried *Ficus sur* fruits (FSF) and maize grain while noug seed cake (*Guizotia abyssinica*) and soybean meal were included to improve protein content of the diet. Treatments comprised of 100% FSF with 0%MG (100FSF), 67% FSF with 33% MG (67FSF), 33% FSF with 67% MG (33FSF) and 0% FSF with 100% MG (0FSF) as presented in Table 1.

Table1: The initial diets and ingredients fed to pigs

Ingredients (g)	Diets (DM basis)			
	100FSF	**67FSF**	**33FSF**	**0FSF**
Ficus sur fruit	1080	724	356	0
Noug seed cake	435.6	396	360	315
Soybean meal	234	216	194	180
Maize grain	0	356	724	1080

FSF= *Ficus sur* fruits; DM = dry matter

Data Collection Procedures

Carcass Yield Evaluation

At the end of the feeding period, the animals were weighed before slaughter (slaughter weight) after overnight fasting. They were slaughtered by severing their heart with long knife. After removing offal, the hot carcass weight was taken immediately after evisceration. The carcass was cut first into two halves (left and right) and then made into different cuts. The viscera organs were also carefully separated. The weights of different carcass components, visceral parts and appendages were taken using digital balance. Data were carefully recorded on empty body weight (EBW), hot carcass weight (HCW), back fat thickness, rib/loin-eye-area, picnic shoulder, buzzton butt, ham, loin, belly and other viscera organs using already prepared formats. All the experimental animals were slaughtered within three consecutive days.

Back fat thickness (cm) was measured using transparent ruler and taken as average of first rib, 10^{th} rib, last rib and last lumbar vertebra fat thicknesses. Regarding the rib-eye area (REA), both the right and left halves were cut between the 10^{th} and 11^{th} ribs perpendicular to the backbone to measure the cross section of the rib-eye muscle. The rib-eye muscle was traced first on transparency paper then on graph paper and the cross-sections were measured using transparent ruler and then the dimensions calculated and multiplied by the number of squares. Finally, the average of right and left REA was taken.

Picnic shoulder was separated from the buzzton butt by making straight cut, dorsal to the shoulder joint approximately 1.5 cm from the dorsal edge of the pelvic bone on the loin side at an appropriate right angle with the belly side. Buzzton but was the part which was left after separation from the picnic shoulder. Total shoulder was the joint weight of picnic shoulder and buzzton butt.

Ham was taken from the hind leg or thigh of carcass from the hook up ward on the live animals. This was removed by cutting at the anterior edge of the symphysis at right angle to the side. Loin was a part of quadruped situated on both side of vertebral column between ribs and hip bone. Its weight was separately taken. Belly was removed from the loin by making nearly straight cut that extends from a point that is ventral to but not more than 3 inches from *longissimus dorsi* on the shoulder end to a point on the leg end ventral to but not more than 1.5 inch from tender loin. Dressing percentage was calculated as percentage of HCW divided by SW. Carcass pH was measured after slaughter immediately after the hot carcass temperature fell and balanced with environmental temperature. The pH was measured in the sample taken from *longissimus dorsi* muscle of carcasses using the WP80 TPS meter in conjunction with a C64-1 combination glass electrode.

Chemical Composition of Feeds and Carcass

Chemical analyses of the feed and carcass samples were performed at Haramaya University Animal Nutrition laboratory. During the feeding periods feed samples were taken each day and accumulated in separate bag. At the end of the feeding trial, the feed in the bag was thoroughly mixed and subsamples were taken for chemical analysis. The samples were partially dried in forced draft oven at 65^{o}C to constant weight. The dried samples were ground to pass 1mm Wiley mill sieve size and labeled for easy identification. After the ground samples were equilibrated with the air at room temperature in the laboratory, hot weighing technique was employed. The DM and ash contents as well as the proximate composition of the feeds samples were determined following AOAC (1995). The N content of the samples was determined by the micro-Kjeldahl method and CP was calculated as NX6.25.

Samples for carcass chemical analysis were taken from *longisimus dorsi* muscle of slaughtered pigs and partially dried in forced draft oven at 65^{o}C to constant weight. The dried sample were ground to pass 1mm sieve size and labeled for easy identification. The proximate composition of feed samples was determined following AOAC (1995). The moisture percentage was determined by difference as 100 minus DM. The N content of the samples was determined by the micro-Kjeldahl method and CP was calculated as N X 6.25. Ca was analyzed by atomic absorption spectroscopy (AAS) but Phosphorus according to Morrison (1964).

Sensory Evaluation

The pork sample for sensory test was taken from similar carcass part, ham, for all animals slaughtered. Thirty three consumer panelists drown among postgraduate and undergraduate students of Food Science and Postharvest Technology of Haramaya University was selected to test the meat using their sense of perception. Orientation was given to the testing panelists to make the testing effective. The panelists were arranged to seat individually in separate places free of any sound, smells or sight that could disturb their sensory perceptions. Cup of water was made available for washing their mouth at the end of tasting each treatment before beginning the other treatment samples. The sample meat was roasted for five minutes using frying pan and coded before presented with white and clean ceramic dishes to consumer panelists individually. Sensory acceptability of the pork for color, flavor/aroma, taste, juiciness, tenderness, texture and overall acceptability variations was conducted on 1 to 5 hedonic scales (5=like extremely, 4=like moderately, 3=like, 2=dislike moderately, 1=dislike extremely) (Resurreccion, 1999).

Statistical Analysis

The data on carcass yield and carcass composition were stratified into treatment and block and analyzed using the General Linear Model (GLM) procedure of Statistical Analysis System, SAS (2008). The sensory preference data was analyzed using the mixed model of Statistical Analysis System, SAS (2008) with the treatments taken as fixed effects and the sense of panelists as random effects (Naes *et al.,* 2010). When the ANOVA declared significant differences among the treatments, means were grouped using Tukey honestly significant difference test at α=0.05.

The model was described as shown hereunder:

$$y_{ijr} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + \varepsilon_{ijr},$$

where, α_i is the fixed effect of the products; β_j is random effect of assessors and $\alpha\beta_{ij}$ the ith fixed effects, jth random effects interactions and ε_{ijr} is the error term.

RESULTS

Chemical Composition of the Experimental Diets

The nutrient content of the feeds used in this experiment is presented in Table 2. The experimental diets had comparable content of the different nutrients. The dry matter (DM), ash, ether extracts (EE) and crude fiber (CF) contents decreased whereas the nitrogen free extracts (NFE) and ME contents increased with decreasing inclusion level of FSF in the diets.

Slaughter Measures and Carcass pH

The different carcass measurements obtained through feeding piglets with FSF mixed with graded levels of MG are shown in Table 3. Significantly higher slaughter weight (*P*<0.05) was achieved by piglets fed with 0FSF diet compared to 100FSF, however, the slaughter weight of those fed with diets containing 67FSF and 33FSF were not significantly different (*P*>0.05) from both 0FSF and 100FSF diets. The *longismus dorsi* area (LMA) was significantly higher (p<0.05) for 100FSF and 67FSF diets than 0FSF diets. There was no significant difference (*P*>0.05) among treatment diets for all other parameters.

Table 2: Chemical composition of experimental diets

	Chemical Composition (%)							
Feed Stuff	**DM (%)**	**OM**	**Ash**	**CF**	**EE**	**CP**	**NEF**	**ME***
Ingradients								
Ficus sur fruit	90.1	87.1	3.0	10.5	5.6	2.0	78.9	12.6
Maize grain	91.0	83.9	7.2	7.3	5.7	14.5	65.4	11.4
Noug seed cake	91.9	82.5	9.4	28.1	9.9	31.5	21.1	10.1
Soya bean meal	93.3	86.6	6.7	43.5	8.7	4.2	36.9	11.3
Dietary Treatments (DM basis)								
100FSF	91.5	84.8	6.68	17.3	7.15	18.2	52.5	11.6
67FSF	91.2	84.7	6.55	14.5	7.04	18.3	54.2	11.7
33FSF	90.9	84.6	6.27	11.5	6.91	18.4	58.2	11.8
0FSF	90.6	84.6	5.96	8.15	6.81	18.5	62.5	12.1

DM= dry matter; OM= organic matter; CF= crude fiber; EE= ether extract; NFE=Nitrogen Free Extract; FSF= *Ficus sur* fruits; ME=Metabolizable Energy; *=MJ/kg DM

Table 3: Effect of feeding graded levels of FSF mixed with MG on pigs' carcass measurements

Carcass attributes	Treatments				SEM	SL
	100FSF	67FSF	33FSF	0FSF		
Slaughter weight (kg)	52.8^{b}	55.0^{ab}	56.1^{ab}	59.3^{a}	1.04	*
Hot carcass weight (kg)	30.6	30.7	31.3	32.8	2.10	ns
Dressing percentage (%)	61.6	63.4	64.2	67.9	2.77	ns
Carcass pH (hot)	6.65	6.68	6.70	6.73	0.06	ns
Carcass pH (24 hours)	5.45	5.48	5.50	5.53	0.06	ns
Carcass length (cm)	65.7	63.9	61.8	61.2	1.23	ns
LMA (cm^2)	23.6^{a}	23.7^{a}	22.5^{ab}	19.7^{b}	0.84	*
Back fat thickness (cm):	2.07	2.26	2.49	2.69	0.24	ns

^{ab}Means with different letters in a row are significantly different; FSF= *Ficus sur* fruits; LMA= *longisimus* muscle area; SEM= standard error of the mean; SL=significance level.

Carcass Primal Cuts

The primal cuts of pigs fed different proportions of dried and ground FSF mixed with graded levels of MG are presented in Table 4. There was no significant difference (P>0.05) in all the primal cuts among the dietary treatments. However, the picnic shoulder, loin and belly, buzzton butt, ham and the jowl cut sizes of the piglets carcass increased in magnitude with decrease in level of FSF inclusion in the diets of pigs.

Table 4: Effect of feeding graded levels of FSF mixed with MG on pigs' carcass cuts

Carcass cuts (kg)	Treatments				SEM	SL
	100FSF	67FSF	33FSF	0FSF		
Picnic shoulder	4.6	5.2	5.4	5.5	0.62	ns
Loin	7.2	8.8	8.8	9.0	0.79	ns
Belly	4.3	5.2	5.3	5.9	0.75	ns
Buzzton Butt	4.3	4.3	4.8	4.9	0.82	ns
Ham	7.1	7.1	7.3	7.7	0.21	ns
Jowl	1.3	1.6	1.8	1.9	0.19	ns

FSF= *Ficus sur* fruits; MG= maize grain; SEM= standard error of the mean; SL= significance level.

Non-carcass Components

The weights of non-carcass or viscera components of piglets as affected by the current dietary treatments are given in Table 5. Except for the lungs, where 0FSF had the highest whereas 67FSF had the lowest, all other visceral organs did not vary significantly (P>0.05) among the treatment diets. The weight of empty gut (GIT) was higher (P<0.05) in pigs fed 0FSF diet than those fed 67FSF and 100FSF diets. Pigs fed 33FSF diet also had higher (P<0.05) empty gut weight than those fed 100FSF diet. IN general, the empty gut weight showed a significant increase with decreasing level of FSF in the diet.

Table 5: Effect of feeding graded levels of FSF mixed with MG on pigs' viscera components

Viscera organs (kg)	Treatments					
	100FSF	67FSF	33FSF	0FSF	SEM	SL
Heart	0.19	0.21	0.18	0.19	0.010	ns
Liver	0.86	1.27	1.10	0.98	0.154	ns
Lungs	0.36^{ab}	0.29^{b}	0.32^{ab}	0.47^{a}	0.035	*
Kidneys	0.16	0.16	0.15	0.13	0.008	ns
Pancreas	0.09	0.08	0.09	0.09	0.007	ns
Omentum fat	0.31	0.33	0.36	0.37	0.038	ns
GIT (empty)	1.73^{c}	1.91^{bc}	2.01^{ab}	2.22^{a}	0.058	***
Blood	2.70	2.40	1.94	3.54	0.518	ns
Total	6.39	6.63	6.18	7.95	0.441	ns

^{abc}Means with different letters in a row are significantly different; FSF= *Ficus sur* fruits; GIT=gastro-intestinal tract; SEM= standard error of the mean; *= P<0.05; ***= P<0.001; SL=significance levels; ns= non-significant.

Carcass Nutrient Composition

The moisture content of the pork was higher (P<0.05) in 100FSF than 0FSF diets and showed a decreasing trend with decrease in the proportion of FSF in the ration (Table 6). The EE content of the meat was higher (P<0.05) in the 0FSF than the 33FSF diet, which in turn had higher (P<0.05) EE content than 67FSF and 100FSF diets. The CP content was higher (P<0.05) in 100FSF and 67FSF diets than the 33FSF and 0FSF diets. No significant differences (P>0.05) were detected among the dietary treatments in ash, calcium and phosphorus contents.

Table 6: Nutrient composition of pork as affected by graded levels of FSF mixed with MG diets

Nutrients (%)	Treatments				Standard Error of Mean	Significance Level
	100FSF	67FSF	33FSF	0FSF		
Moisture	72.1[a]	70.9[ab]	69.8[ab]	68.5[b]	0.782	*
Ash	1.80	1.76	1.75	1.73	0.079	ns
EE	5.49[c]	5.96[c]	6.78[b]	8.04[a]	0.145	***
CP	21.2[a]	21.1[a]	20.2[b]	19.9[b]	0.189	***
Ca	0.04	0.04	0.03	0.03	0.001	ns
P	0.71	0.69	0.68	0.67	0.022	ns

[abc]Means with different letters in a row are significantly different; FSF= Ficus sur fruits; MG= maize grain; 5=like extremely, 4=like moderately, 3=like, 2=dislike moderately, 1=dislike extremely; SEM= standard error of the mean; SL=significance level; ns= non-significant; *= P<0.05; **= P<0.01; ***= P<0.001

Carcass Sensory Quality

The result of sensory appraisal for carcass of pigs fed different proportions of dried and ground FSFs and MG is depicted in Table 7. All the carcasses tested were liked by the panelists as all the scores on hedonic scale were above 3. The color (P<0.01), taste (P<0.05), juiciness (P<0.001) and tenderness (P<0.05) sensory attributes showed significant difference between treatments while the rest were non-significant. Color and taste preferences were higher (P<0.05) for meat of pigs that were fed with 100FSF than those fed 0FSF diet whereas tenderness was higher (P<0.05) in 0FSF than 100FSF diets. Juiciness was higher (P<0.05) for meat from pigs fed 0FSF than those fed 67FSF diet. The meat from pigs fed 33FSF diet was significantly higher (P<0.05) in juiciness than the 100FSF diet. In general, the juiciness of the meat increased with decreasing inclusion level of FSF in the diet. The carcass for pigs grown on 100FSF diets was reddish in color with less fat proportions while that of 0FSF was dominated by fat. The pigs received 100FSF diets resulted in best tasting pork with the least for 0FSF in decreasing trend. The panelists also identified that 100FSF diets resulted in the least juicy pork while the highest was for 0FSF in consistent trends.

Table 7: The effect of graded levels of FSF mixed with MG diets on major sensory preferences of pork

Sensory preference Parameters	Dietary Treatments				SEM	SL
	100FSF	67FSF	33FSF	0FSF		
Color	4.00[a]	3.67[ab]	3.58[ab]	3.27[b]	0.130	**
Taste	3.85[a]	3.73[ab]	3.42[ab]	3.36[b]	0.122	*
Flavor	3.27	3.39	3.18	3.09	0.196	ns
Juiciness	3.21[c]	3.39[bc]	3.73[ab]	3.85[a]	0.100	***
Tenderness	3.30[b]	3.61[ab]	3.70[ab]	3.79[a]	0.110	*
Texture	3.76	3.97	3.97	3.48	0.195	ns
Overall acceptance	3.58	3.79	3.73	3.54	0.091	ns

[abc]Means with different letters in a row are significantly different; FSF= Ficus sur fruits; MG= maize grain;5=like extremely, 4=like moderately, 3=like, 2=dislike moderately, 1=dislike extremely; SEM= standard error of the mean; SL=significance level; ns= non-significant; *= P<0.05; **= P<0.01; ***= P<0.001

DISCUSSION

Chemical Composition of Experimental Diets

The higher mean DM content of FSF was more important for higher feed intake of animals, when offered as fed basis, compared to that of MG. The higher ash composition of FSF compared to MG diets implies that these fruits may be contaminated by soil since the dried fruits were collected after they fall on the ground. Considerable fiber contents of the FSF, also helps the pigs to utilize such diets through microbial fermentation activities in their large intestine (Williams *et al.,* 2005). Relatively better ether extract values of FSF, together with higher fiber composition, helps to minimize variations in energy concentration with that of MG that contained higher nitrogen free extract. As shown by the chemical composition analysis result, most of the nutrient limited in one of the diets could be complemented by the other and *vice versa*.

Slaughter Measures and Carcass pH

The slaughter weights of the pigs in the present study was comparable with that of the Caribbean growing pigs fed ground sugarcane stalks supplemented with molasses (Xandé *et al.,* 2010) but with lower dressing percentage. Different researchers reported similar result on reduction of carcass pH after 24 hours (Sather *et al.,* 1999; Pulkrabek *et al.,* 2006; Martin *et al.,* 2008). This could be attributed to glycogen breakdown in the muscles (McIntyre, 2006). Glycogen stored in the muscle of animals acts as an energy source for physical activity. After slaughter, stored muscle glycogen is broken down and produces lactic acid. As lactic acid accumulates, the pH of the muscle falls from an initial level of around 7.00 in the live animal. When the pH is about 6.00, the muscle goes into rigor and starts to stiffen. Hence, the optimum or 'normal' pH of meat is between 5.40 and 5.60 but a pH over 5.70 is regarded as unacceptable (McIntyre, 2006).

Pigs consumed 0FSF diets resulted in the highest backfat thickness while 100FSF had the least. This means the treatment in which higher MG level included was resulted in higher backfat thickness. Higher backfat thickness was an indication of higher fat proportion of the carcass for those pigs consumed 0FSF diets. This implies that unlike the effect of MG, the FSF which resulted in lower backfat thickness relatively signify quality pork

Carcass Primal Cuts

The absence of significant differences between the carcass cuts of pigs fed FSF and those fed MG indicates that FSF had comparable potential as diets of pigs and this also was confirmed by the chemical assay results. Camp *et al.* (2003) cited that dietary sucrose addition improved carcass characteristics than starch type of corn. Sucrose is the carbohydrate (disaccharide) that promotes sweet characteristics of diets and FSF is sweet and edible to human as well. Hakeem *et al.* (1994) reported that mixing not more than 33% level of sweet potato with maize grain had promising effect on carcass performance of pigs. Such situations lead to the suggestion that there might be sucrose in FSF that brought about comparable yield of carcass primal cuts. In addition to promising feed value of FSF, the efficiency of pigs to utilize feeds might have narrowed the gap in body weight change and thereby the ultimate carcass yields of the pigs fed these dietary treatments (Lekule and Kyvsgaard, 2003).

Similar carcass yield result was reported by Chiba *et al.* (2002) for pigs kept on dietary restrictions. The carcass primal cuts in the present study are higher than that of similar weight pigs fed *ad libitum* of pelleted diets designed to provide adequate nutrients for expression of their maximum protein accretion during the respective growth periods (Landgraf *et al.,* 2006). Other researchers (Yin *et al.,* 2001) found higher carcass values, than the present results, for growing Cotswold pigs fed different cereal grains.

Non-carcass Components

Unlike the meat consumption culture of Ethiopia, which is limited to few internal organs like liver, heart, kidney and parts of empty gut for small ruminants, other societies have diverse consumption habit (Niels *et al.,* 2005; Anke *et al.,* 2006) including lungs and related organs of pigs. The total viscera mass in the present study was slightly lower than that of similar weight pigs fed *ad libitum* of pelleted diets designed to provide adequate nutrients for expression of their maximum protein accretion during the growth periods (Landgraf *et al.,* 2006).

Carcass Nutrient Composition

Analysis of the chemical composition of carcass helps to identify the major nutrients available in the pork of pigs consumed the respective dietary treatments and distinguishes the quality of carcass products and consumer acceptability (Kerry *et al.,* 2002). For example, higher dressing percentage for piglets received 0FSF could be in part attributed to body fat of the animals as observed from the highest EE values. The higher moisture content in 100FSF diets was less relevant in cases where meat preservation is through dehydration (Zeuthen and Bùgh-Sùrensen, 2003). It may, however take time on the traditional air drying or requires relatively more salt in salt drying methods.

The highest composition of EE in 0FSF indicates that the pork from these same treatments had high amount of fat content, which is considered to cause a variety of human diseases. It has been reported (Department of Health, 1994) that high proportion of saturated fatty acids (SFA) could raise blood cholesterol levels, a risk factor for cardiovascular disease. Although optimum fat content improves sensory values of meat, the fat composition above optimum can cause negative hedonic qualities (Melton, 1990) as it produces volatiles. Other authors (Hui *et al.,* 2001) noted that the optimum lipid value of meat was 5% of the carcass, which is almost similar with the carcass of pigs fed 100FSF in the present study. However, the EE content of the carcass of those pigs fed 0FSF, maximum MG levels, was much higher than these optimum values indicating that pigs fed with 100FSF can yield better quality pork compared to those fed 0FSF.

The increase in CP content of the carcass with increasing level of FSF in the diet could be due to less fatty nature of the carcass obtained from pigs consumed higher proportion of FSF. Carcass with high CP constituent results in better leanness, the trait that is preferred by most consumers around the world (Tsegay, 2013). Resurreccion (2003) also stated that continued interest and demand exists for low- and reduced-fat meat products which are being developed in response to health concerns of consumers. This is because nutrient density of muscle is higher in lean meat (Hui *et al.,* 2001). Such kind of meat product is mostly preferred since it does not encourage cholesterol development in the cardiovascular system of the consumers. Moreover, the sera of these pigs were observed to contain the highest Hgb concentration (Diriba *et al.,* 2014) which indicates higher content of the element Iron in their blood. Existence of higher Iron in other words indicate that there must be better myoglobin development (red meat) in the meat of pigs received 100FSF because Iron is, not only for hemoglobin, but also an essential component of myoglobin (Olver *et al.,* 2010).

Carcass Sensory Preference

The highest color preference for pork from pigs fed 100FSF diets suggests that increased levels of FSF in pigs' diet could improve color quality of pork. The most reddish color visually observed in carcass of pigs received 100FSF diets could be due to higher myoglobin concentration (Owen and West, 2001) which was in turn an attribute of higher iron mineral in FSF than MG diets (Diriba *et al*., 2014). Apple *et al*. (2013) noted that feeding 100 ppm Fe with pigs brought some improvement in pork color during retail display. Pork from groups of pigs fed 100FSF also produced the most preferred taste of carcass. However, the reason behind the taste chemistry for the pork in the present study was not clear except panelists' preference.

The overall impression of tenderness to the palate involves three aspects: firstly, the initial ease of penetration of the meat by the teeth; secondly, the ease with which the meat breaks into fragments; and thirdly, the amount of residue remaining after chewing (Lawrie and Ledward, 2006). Even though the carcass of pigs consumed 0FSF demonstrates these scenes, however, the highest preference for tenderness in the carcass of pigs fed these diets in the present study might be due to juicier characteristic of the meat. This implies that such type of carcass lacks leanness unlike those fed 100FSF.

The least preference for juiciness of the pork from pigs fed 100FSF was due to non-excess intra muscular fat content of their carcass (Bertram *et al.,* 2007) compared to those fed 0FSF. Such meats are leaner and optimum fat which most meat industries around the world were capitalizing on (Resurrection, 2003). Tischendorf *et al.* (2002) reported similar score for juiciness of pork raised on barely energy diets showing that FSF diets could produce better or similar quality pork as most cereal grains do. Resurrection (2003) reviewed that the most common factors, among others, affecting demand for meat are good taste, tender, lean, healthy and nutritious, most of which are demonstrations of meat from pigs fed 100FSF in the present study. Such qualities enhance the demand for the pork which in turn affects willing to pay for the pork and thereby enhance income.

CONCLUSIONS

The experimental result revealed that feeding maximum levels of FSF can give comparable carcass yield; better carcass nutritive value and better eating quality (sensory preference) of pork than feeding with maximum level of MG diets in the ration. It is therefore, concluded that substitution of MG with FSFs in the diets of pigs did not affected yield, nutrient content and sensory preference values of pork and can be used as alternative energy source ingredient at least in smallholder pig production system.

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