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Sensory Characteristics of Pork Fed Hatchery Waste Meal as Replacement of Fish Meal

Asiedu,[1*]P., Andoh[1], S., Osei[2], D.Y., Bumbie[2], G. Z., Oduro-Owusu, A.D., Asuming-Bediako[1] N. and Odoi[3,] F. N. A.
[1]*Department of Animal Production and Health, School of Agriculture and Technology, University of Energy and Natural Resources, Dormaa Campus, Ghana*
[2]*Council for Scientific and Industrial Research, Animal Research Institute, Achimota, Accra, Ghana*
[3] *Animal Science Department, School of Agriculture, Cape Coast University Cape Coast, Ghana*
**Corresponding Author's email: peter.asiedu@uenr.edu.gh*

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ABSTRACT

A twelve (12) week experiment was conducted to investigate the effect of hatchery waste meal (HWM) on sensory characteristics of pork meat. Eight (8) grower pigs from each treatment were randomly selected and used for sensory evaluation. Five (5) grams each of muscle samples were obtained from the longissimus dorsi of the carcasses, pan-fried using 300 ml of Frytol®vegetable oil at 170 °C for 10 minutes. Eighty (80) untrained evaluators conducted the sensory evaluation according to the consumer acceptance and preference testing technique on a nine-point hedonic scale comprising appearance, flavour, colour, mouth-feel, taste, texture and overall acceptability. The experimental diets had no significant effects (p>0.05) on the organoleptic properties (appearance, colour, aroma, juiciness, tenderness, taste, mouthfeel and overall acceptability) assessed in the meat of fried pork. The treatment with 7.5% HWM differed significantly (p< 0.05) from the rest of the test diets but similar (p > 0.05) to the control for overall acceptance. For taste, significant (p< 0.05) differences were recorded across the grilled dietary treatment, 7.5 % HWM had the highest value of 7.43 followed by 0 % HWM with a value of 7.30 and 10.0 % HWM with the least value of 5.5 respectively. It can be concluded that HWM as an ingredient in grower-finisher rations will not have adverse effect on the sensory characteristics of both grilled and fried pork.

Keywords: *Frying, grilling, grower-finisher pig, pork meat, sensory characteristics*

INTRODUCTION

The increasing cost of feed resources in pig production have been identified as a serious impediment to meeting the demand for animal protein, particularly in developing countries (Adejinmi *et al*., 2000). The search for such alternatives has been the focus of Animal Nutritionists for over decades (Onyimonyi and Okeke, 2005). The use of animal wastes or by-products has considerable significance in the diets of livestock (González-Félix *et al*., 2011). Subsequently, researchers are currently focusing more on replacing fish meal with relatively cheap or animal protein sources (Bulut *et al* 2014). One of such animal waste products is hatchery waste meal (HWM), a hatchery by-product, or waste generated from the poultry industry. Pork, a meat-type of pig; that has the ability to grow fast and reach market weight faster than ruminants (Madubuike and Ekenyem, 2001) has stirred up interest in many farmers, because it plays a significant role as animal protein source in human diets by supplying essential amino acids needed for growth, development, and repair of worn-out tissues. Meat is an important foodstuff and one of the most expensive components of human nutrition (Šubrt and Mikšik, 2002).

Meat provides valuable amounts of protein, fatty acids, vitamin, minerals and other bioactive compounds. The demand for lean meat is rapidly increasing since today's consumers have become more health conscious (Bizkova, and Tumova, 2010). Quality meat evaluation is important in improving meat production (Barbera and Tossone, 2006), and carcass palatability and acceptability to the consumer depends on carcass quality (Christensen *et al.*, 2000). An early Swedish study (Chodová *et al.,* 2019) indicated that price and taste were the main concerns when it came to the consumers' choice of meat, and it again showed that the consumers' requirement regarding meat was firstly freshness and secondly good flavour. The demand for meat could be based on several other factors such as an actual perception of food from a sensory point of view, the consumer's physiological state, short-term food habits and long-term food culture (Apata *et al.,* 2012). A recent study about consumer preferences showed that taste is the most important quality criterion for the consumer (Yıldırım *et al* 2014).

Sensory evaluation has been defined as "a scientific method used to suggest, measure, analyse, and interpret those responses to products as perceived through the sense of sight, smell, touch, taste and hearing" (Fiorentini *et al*., 2020). Sensory analysis is a useful tool when evaluating the eating quality of food and is nowadays frequently used both within the food industry and research. Sensory analysis can be used in quality control (e.g. raw material, process and product), product development (copying competing products, product improvement) and shelf-life evaluation (Palazzo *et al.,* 2015). The aim of this study was to determine the effect of HWM on sensory characteristics of pork meat.

MATERIALS AND METHODS

Location of experiment

The experiment was carried out at the CSIR-Food Research Institute's sensory laboratory, Accra, Shiashie, Adjacent Ghana Standards Board, New Gulf House, Near Tetteh Quarshie Interchange, Gulf St, Accra, Ghana. *Ghana Post* GPS address of the location is GA-107-2878 which lies in the Transition belt and situated in the Accra Metropolitan Assembly Area of the Greater Accra Region of Ghana.

Experimental diets

Five (5) experimental diets were formulated to contain 0%, 2.5%, 5.0%, 7.5% and 10.0% HWM. They were formulated to meet all requirements for essential nutrients in grower-finisher pig diets as recommended by NRC (1998). All the diets were formulated to be isocaloric and isonitrogenous. Table 1 shows the feed ingredients, levels of inclusion, and the calculated and analyzed composition of individual nutrients in the experimental diets as replacement for fish meal.

Simple Sensory Testing Laboratory

The CSIR-Food Research Institutes sensory laboratory has panel booths and a discussion area, built adjacent to an existing kitchen facility. The food preparation area is well equipped with stoves, sinks, refrigerators, storage cupboards and counter space. The newly designed sensory facility has panel booths which are accessible from the kitchen via pass-through with horizontal sliding doors. The five panel booths are open from the back to the group discussion area which is equipped with a table, and with stool in each booth to seat 10 people at a time.

Slaughtering and Dressing of pigs

Eight (8) grower pigs were randomly selected from each dietary treatment group and used for sensory evaluation at the end of a 12-week feeding period. After 24-hour feed withdrawal, pigs were slaughtered at the Meat Processing Center of the Council for Scientific and Industrial Research-Animal Research Institute (CSIR-ARI). An electric stunner was used to stun the pigs after which they were then stuck with a sharp knife to cut the jugular vein and carotid artery, and allowed to bleed for about 2 minutes. Pigs were scalded with hot water immediately after bleeding and the remaining hairs were singed with a blow pump lamp, using Liquefied Petroleum Gas (LPG) as fuel. The carcasses were then hanged, washed and eviscerated. The dressed carcasses were chilled and deboned manually and the *longissimus muscles* obtained was packed in a regular low-density polyethylene (LDPE) bags labelled A(0.0% HWM), B(2.5% HWM), C (5.0% HWM), D(7.5% HWM) and E (10.0% HWM) and stored in the freezer (-18±1°C) until ready to be use.

Table 1: Composition of experimental diets containing varying levels of hatchery waste meal

Diet	(%) Levels of HWM inclusions in the diet				
	0% HWM	**2.5% HWM**	**5.0% HWM**	**7.5% HWM**	**10.0% HWM**
Fish meal	10.00	7.50	5.00	2.50	0.00
Hatchery waste meal	0.00	2.50	5.00	7.50	10.00
Maize bran	60.00	39.00	32.00	28.00	18.25
Wheat bran	2.25	14.25	16.25	18.25	25.00
Soybean meal	0.50	5.00	10.00	12.00	15.00
Palm kernel cake	25.50	30.00	30.00	30.00	30.00
Oyster shell	1.00	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50	0.50
Premix	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated composition % (as fed/DM)					
ME (MJ/kg)	13.90	13.75	13.99	13.50	13.43
Crude protein	16.43	16.40	16.41	16.44	16.43
Ether extract	7.67	8.05	8.66	8.91	9.32
Crude fiber	6.80	6.58	7.81	8.40	8.37
Calcium	0.83	1.69	2.63	1.73	3.49
Available phosphorus	0.32	0.27	0.22	0.19	0.13
Analysed composition % (as fed/DM)					
ME (Kcal/Kg)	12.92	12.77	12.45	12.41	12.59
Crude Protein	16.46	16.35	16.30	16.96	16.11
Ether extract	7.73	8.23	8.44	8.76	8.87
Crude Fibre	11.48	12.44	14.25	14.69	13.33
Ca	1.34	1.91	1.92	1.99	2.05
P	5692.18	5903.68	6945.78	7045.14	7204.59

**Vitamin and TMP (Trace Mineral Premix): Inclusion rate is 25 kg/tonne to supply the following per tonne of feed: Vit.A, 2,000,000 IU; Vit.E, 15000 mg; Vit.B1, 1500 mg; Niacin 30,000 mg; Vit.B6, 1500 mg; Vit.D3, 4500,000 mg; Vit. K3, 3,000 mg; Pantothenic acid,12000 mg; Vit.B12, 10,000 mg; Vit. B2,6000 mg; Folic acid, 800 mg, Iron, 60,000 mg; Copper 75,00 mg; Iodine, 750 mg; Manganese, 130,000 mg; zinc, 70,000 mg; Selenium, 300mg. calcium,17.50%, Lysine, 1,330 mg; Methionine, 1,075 mg; B-Corotenic acid, 350 mg.*

Sample Preparation
A total weight of 500 grams of garlic and ginger were blended separately with 150 ml of water into a smooth paste. Out of which the following quantities were fetched. Two cooking methods were used which included frying and grilling.

Ingredients
The ingredient used are as follows: salt -1 table spoon (tbs), ginger-2.5 tbs, garlic-2.5 tbs, water – 100 mls, and vegetable oil– 300 mls.

Frying
Pork samples were weighed, washed and cut into pieces of 5 grams each. It was spiced and left for 10 minutes. Hundred (100) mls of water was added to each of the samples and steamed for 10 minutes. Meat was fried using 300 ml of oil for 10 minutes and was then removed from oil into a colander to drain off excess oil. Samples were kept in a food warmer prior to the sensory evaluation session.

Grilling
Pork samples were weighed, washed and cut into pieces, 5 grams each. It was spiced and left for 10 minutes. Oven was pre-heated at a temperature of 100°C. Baking trays were greased with oil before the samples were being arranged in it for grilling. Grilling was done at a temperature of 120°C for 20 minutes and meat was cooled and serve for sensory evaluation.

Sensory Evaluation
The consumer panel consisting of students, national service personnel and staff of the CSIR-Food Research Institute, were used to evaluate sensory characteristics of the pork. Consumer panelists (at least 80 untrained, randomly chosen individuals) were selected based on their frequency of meat consumption and willingness to participate in the test. The untrained panelists with the help of questionnaire were asked to use the nine-point hedonic scale to score the degree of likeness for the samples. Panelists were served with cucumber as pallet cleanser after tasting one sample before moving to the other. Samples were treated equally and coded to prevent error and promote objectivity. The coded meat samples were randomly served to the assessors on clean saucers for sensory evaluation based on a nine-point hedonic scale on which scale 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely) for appearance, colour, flavour, texture, taste, mouth feel and overall acceptability (Apata *et al*., 2012).

Pork were chopped into 1 square inch pieces, wrapped in foil and served to panelists. The sensory attributes assessed included: appearance, colour, taste, aroma, texture, mouth feel and overall acceptability**.** Overall like/dislike flavour, overall like/dislike texture, level of tenderness and level of juiciness attributes were evaluated for each sample using a 9-point hedonic scale (Carr *et al*. 1999). Their responses were recorded on attached assessment sheets. Panelists evaluated a total of five samples presented in random order and coded. A score of 1 represented attribute “dislike extremely” and a score of 9 represented attributes “like extremely”.

Table 2: Coded samples of fried and grilled pork

Sample	Fried pork	Grilled pork	Weight (g)
A	236	101	500
B	772	580	500
C	414	670	500
D	510	700	500
E	627	860	500

A (0.0 % HWM), B (2.5 % HWM), C (5.0 % HWM), D (7.5 % HWM) and E (10.0 % HWM)

Statistical Analyses
All data were analyzed using the Generalized Linear Model of the Genstat Discovery Edition (VSN, 2016) to produce an analysis of variance (ANOVA) and the means were compared using the least significance difference. Differences were considered significant at ($p < 0.05$). Statistical analysis of sensory data was based on a two -way non-parametric procedure.

RESULTS AND DISCUSSION
Sensory Evaluation of fried Pork
Some sensory characteristics of fried pork fed graded levels of HWM are shown in Table 3.

From table 3, the experimental diets had no significant effects ($p > 0.05$) on the organoleptic properties (appearance, colour, aroma, juiciness, tenderness, taste, mouthfeel and overall acceptability) assessed in the meat of fried pork.

Consumer acceptance of quality meat such as tenderness, juiciness and flavour of meat is the major determinant of meat quality (Maltin *et al*., 2003).

From table 3, the results from the study indicated that there were no significant ($p > 0.05$) differences in sensory evaluation of fried pork from the various treatment groups. This shows that HWM in the experimental diets did not interfere with the organoleptic qualities of the meat produced. These finding is in agreement with previous work on sensory assessment on loin from pigs on HWM based diet (Apata *et al*., 2017). Several investigations have also indicated the influence of frozen storage and thawing on sensory evaluation, with contradictory results. Rodrigues and Teixeira (2013) found that sensory evaluation was unaffected by freezing, frozen storage and thawing.

Sensory Evaluation of grilled Pork

Some Sensory characteristics of grilled pork fed different inclusion levels of HWM are presented in Table 4. The appearance, aroma, taste, colour and tenderness of the grilled product were all not significantly ($p > 0.05$) influenced by the dietary treatments. This finding agrees with Lawrie and Ledward (2006) who reported a similar colour and appearance liking of the products which were advantageous, as meat purchasing decisions are influenced more by product appearance than any other quality factor. In a similar study, Dinh and Nhat (2006) pointed out that colour of meat is the major attribute that gives the first impression that consumers have about meat and influences their selection of meat. However, our findings showed significant ($p < 0.05$) differences in the taste, mouth feel and acceptance, with data revealing increased value with increased HWM inclusion in diet. Also, pigs fed with 7.5% HWM had a higher significant ($p < 0.05$) value compared to pigs fed with 10.0% HWM in diet, indicating an increase in the HWM above 7.5% HWM may negatively affect taste, mouth feel and overall acceptance of grilled pork. High palatability attributes from grilled pork in treatment 0% HWM and 7.5% HWM could have been responsible for its high overall acceptability.

Although the sensory analysis was not designed to evaluate the HWM effect directly, a comparison of Tables 3 and 4 demonstrates that there were hardly any differences between the two cooking methods in relation to colour, appearance, aroma and tenderness. It is important to

Table 3: Effect of replacing fishmeal with HWM on some sensory characteristics of fried pork fed experimental diet

Parameters	HWM 0.0%	HWM 2.5%	HWM 5.0%	HWM 7.5%	HWM 10.0%	SEM	P - value
Appearance	6.97	7.17	7.57	7.13	7.43	0.97	0.29
Colour	7.17	7.20	7.40	7.20	7.40	0.97	0.88
Aroma	6.80	7.03	7.10	6.90	7.23	0.66	0.09
Tenderness	6.70	6.77	6.83	7.07	7.13	0.11	0.73
Taste	7.00	6.73	7.00	7.00	7.23	0.11	0.38
Mouth feel	6.60	6.87	6.73	7.13	7.27	0.12	0.38
Acceptance	7.17	7.27	7.00	7.47	7.73	0.09	0.12

**a, b- Means in the same row with different superscripts are statistically significant ($p<0.05$)*
Sensory variables were rated on a 9-point hedonic scale where 1 = dislike extremely and 9= like extremely.

Table 4: Some sensory characteristics of grilled pork fed graded levels of HWM

Parameters	0% HWM	2.5% HWM	5.0% HWM	7.5% HWM	10.0% HWM	SEM	p - value
Appearance	7.40	6.73	7.23	7.13	7.30	0.10	0.21
Colour	7.23	6.77	7.17	7.20	7.10	0.10	0.51
Aroma	7.23	6.53	7.10	6.90	7.23	0.10	0.14
Tenderness	7.27	6.40	6.97	6.83	6.97	0.11	0.20
Taste	7.30^{a}	7.10^{a}	7.13^{a}	7.43^{a}	5.50^{b}	0.12	0.00
Mouth feel	7.30^{a}	7.30^{a}	7.0^{ab}	6.73^{b}	5.83^{c}	0.11	0.00
Acceptance	7.40^{a}	7.33^{b}	7.33^{b}	7.47^{a}	6.23^{c}	0.12	0.00

**a, b- Means in the same row with different superscripts are statistically significant ($p<0.05$)*
Sensory variables were rated on a 9-point hedonic scale where 1 = dislike extremely and 9= like extremely.

note that individual tenderness and taste scores for control loin pieces for fried, with corresponding scores for grilled samples, numerically did not differ much. These could be as a result of the similar storage methods used (Omojola, 2007; Kowalska, 2008). It has been shown that, frozen storage of meat is a good method for preservation and factors which influence the quality of frozen meat are freezing rate, length of frozen storage and storage conditions such as temperature, humidity and packaging materials (Wood *et al*., 2004). It had been reported (Birren, 1963 as cited by Fiorentini *et al*., 2020) that colour is used everywhere and that, psychological responses to colour, as they relate to appetite, are considered important to processors and consumers. It is worth noting that consumers will often reject products in which the colour varies from the expected normal appearance.

Research has shown that when the sensory attributes of meat products vary significantly from the acknowledged, such products will be rejected by consumers (Teye *et al.,* 2011). Since the HWM diets fed to the pigs had similar sensory characteristics as those raised on the control diet, it is an indication that HWM as an ingredient in grower-finisher rations will not have adverse effect on the sensory characteristics of pork meat. Therefore, HWM could be readily used by farmers with little fear of consumer rejection of pork from pigs raised on HWM.

CONCLUSION

From the result of this study, it appears that up to 7.5% of HWM can be incorporated in the diet of grower-finisher pigs without a marked detrimental effect on sensory attributes. It can be concluded that HWM as an ingredient in grower-finisher rations will not have adverse effect on the sensory characteristics of both grilled and fried pork. Consequently, HWM could be readily used by farmers with little anxiety of consumer rejection of pork raised on them.

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