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ORIGINAL RESEARCH ARTICLE

Effect of partial replacement of pork with edible palm weevil larvae (*Rhynchophorus phoenicis F*) on nutrient, textural and sensory qualities of frankfurter-type sausage

[1]Agbango, A. C., *[2]Awodoyin, O. R, [2]Adediran, A. O and [2]Omojola A. B

[1] College of Agriculture and Natural Resources, Department of Animal Sciences, Kwame Nkrumah University of Science and Technology, Ghana
[2]Animal Products and Processing Unit, Department of Animal Science, University of Ibadan
*Corresponding author E-mail: kasyem@yahoo.com; +2348027290842

ABSTRACT

The advocacy towards healthy life style have necessitated the production of low-fat meat products. Palm Weevil Larvae (PWL) is nutrient-rich and usually incorporated into foods. However, information on the quality and consumer acceptability of frankfurter incorporated with PWL is scanty. The PWL was obtained from a reputable farm, cleaned of dirt, washed, head removed and grounded. Five batches of frankfurter were produced following standard procedures. The control (T_0) contains 70% pork, 10% lard and 20% other ingredients (curing salt, ice packs, phosphate and spices/seasonings). In T_2, T_3, T_4 and T_5 different amounts (5, 10, 15 and 20%) of grounded PWL (GPWL) was substituted for pork while other ingredients remained the same. Five independent replicates of each batch were prepared same way but separately. Cooking loss (CL, %), water holding capacity (WHC), proximate composition (%), texture profile analysis (TPA) and sensory attributes were determined using standard procedures. Data obtained were subjected to ANOVA at $\alpha_{0.05}$. The CL of 18.75 (T_4) and 27.61 (T_5) were higher (P<0.05) than 13.12 (T_1), 14.36 (T_2) and 14.19 (T_3), while WHC of 16.30 (T_1) and 15.00 (T_2) were higher (P<0.05) than 14.60 (T_3), 12.20 (T_4) and 13.70 (T_5). The moisture content (62.30) of 70% pork frankfurter was significantly higher (P<0.05) than GPWL frankfurters. The crude protein (18.18) and ash contents (7.50) of 10% GPWL frankfurter were higher (P<0.05) than other frankfurters, while the ether extract (16.10) of 5% and (17.10) 10% GPWL frankfurter were lower. The TPA showed that the adhesiveness, chewiness, gumminess and hardness of frankfurter with 10% GPWL inclusion were better, while its sensory attributes (tenderness, juiciness and taste) were not significantly different from the control frankfurter. Partial substitution of pork with palm weevil larvae in frankfurter up to 10% improved its nutritional qualities and therefore recommended.

Keywords: Frankfurter, Sensory quality, Palm weevil larvae, Nutrient profile, ,

INTRODUCTION

The increasing advocacy towards healthy products and change in the consumer eating habits for healthier food have necessitated the research for new alternatives in developing healthy meat products (Bis-Souza *et al*., 2018). Raw materials which is low in fat but with high nutritional characteristics can serve as an alternative in the reformulation of meat products (Ignacio *et al*., 2020).

Edible African palm weevil larvae, *Rhychophorus phoenicis (F)* is one of the popular insects consumed as food in Africa and plays an important role in the food culture in this region (Adedire and Aiyesanmi, 1999). It is a nutrient-rich (25.04% protein, 50.23% fat, 12.60% fiber and 3.91% ash) (Rumpold and Schluter, 2013) traditional cuisines that can serve as occasional delicacy, food replacement (Mutungi *et al*., 2019) or merged with foods (Ahensu *et al*., 2019). They have excellent production efficiency (Elemo *et al*., 2011; Parker *et al*., 2017) and provide a good source of energy, minerals and vitamins (Kohler *et al*., 2019; Nongonierma and FitzGerald, 2017; Zielinska *et al*., 2015). However, despite its high nutritional benefits, its consumption has been low thereby neglecting the full potential of their nutrition and economic values (Ayensu *et al*., 2019). Thus, their incorporation in widely consumed meat products such as frankfurter can encourage healthier consumption habits and help in the reduction of problems related to public health.

Frankfurters are types of sausage frequently consumed as meat products and enjoy widely consumer acceptance in the global population (Delgado-Pando *et al.*, 2010). The meat product is basically cylindrical in shape, made from finely minced meat such as pork, beef, lamb or chicken and seasoned with herbs, spices, salt, preservatives, fillers and other ingredients (Kang *et al*., 2014; Wan Rosli *et al*., 2015). The quality of the meat product prepared from other meats such as turkey and duck have also been reported (Namrye Lee, 2018). However, there is no comprehensive report on the quality and consumer acceptability of pork frankfurter partially replaced with Palm Weevil Larvae (PWL). Hence, the aim of this development is to enhance the nutritional profile and textural attributes, while maintaining acceptable taste and flavour of frankfurter incorporated with PWL.

MATERIALS AND METHODS

Location of study

The experiment was carried out at the Meat Science and Processing Unit of the Department of Animal Science Kwame Nkrumah University of Technology (KNUST) Kumasi, Ghana.

Sources of raw materials

Palm weevil larvae (PWL) were obtained directly from a farm in Ejisu while lean pork and lard were purchased from the Kumasi abattoir all in Ghana. The ice packs and food grade curing salt and phosphates were obtained from the Meat Science and Processing Unit of the Department of Animal Science, Kwame Nkrumah University of Technology (KNUST) Kumasi, Ghana. All other ingredients were purchased from Kumasi central market in Ghana.

Frankfurter production

Lean meat and lard were minced via meat grinder (Model W777 #5 LEMTM) through a 3 mm plate (Tangkham, and LeMieux , 2017). The PWL were also cleaned of dirt, washed and head removed before grinding.

The formulation of frankfurter followed the method of Wan Rosli *et al*. (2015) (Table 1). Grounded palm weevil larvae (GPWL) were used at different ratios as a substitute for pork in the frankfurter. There are five different treatments consisting of control and four formulations of frankfurter containing grounded PWL. The percentage of salt, spices and fat remain unchanged with the control sample, while the percentage of meat decreases with increase in grounded PWL content. Differing amounts of pork (5, 10, 15 and 20%) were replaced with the same portion of GPWL (T_2 5, $T_3$10, T_4 15 and T_5 20). Research has shown that substitution level of poultry meat in sausage production did not exceed 20% (Sduza *et al*., 2019) hence, the need not to exceed the replacement of 20% inclusion of GPWL. Five independent replicates of each batch were prepared in the same way and each replicate was grounded separately. The average weight, length and diameter of each sample were 300g, 100mm and 26mm, respectively. The test samples were sealed and stored in a freezer at -18°C until further analyses (Huda *et al.*, 2010).

Parameters measured

pH

The pH was measured using a digital pH meter (MP 230, Mettler Toledo, Switzerland). Approximately 3 g of cooked frankfurter sample was added to distilled water (27 mL). The pH meter was calibrated using standard buffers of pH 4.0, 7.0 and 9.0 at 25 C (Jin-Kyu Seo *et al*., 2016). This was determined on the emulsion (batter) and frankfurter and measurements were performed in triplicates.

Nutrient composition analysis

All samples were analysed for proximate composition which include moisture, crude protein, crude fat and crude ash according to AOAC (2007) procedures. Moisture was determined through the air-oven method while total protein, fat and ash were determined by Kjeldahl, Soxhlet extraction and dry-ashing methods, respectively. All measurements were replicated in triplicates.

Cooking loss and cooking yield

This was determined using the method of Yang *et al*. (2007). Weight of uncooked and cooked sausages was recorded. The yield due to cooking was determined for each treatment-replication combination. The cooking loss was calculated as follows: Cooking loss (%) = (uncooked weight (g) – cooked weight (g) / uncooked weight (g)) × 100

Water holding capacity

Water holding capacity was determined following the procedure of Dzudie *et al*. (2005) with some modifications. A sample of 0.3 g was placed between two filter paper grade 1 and pressed between two 12x12 cm plexi-glass plates for 20 min under 1 kg of weight pressure. Due to the force exerted on the sample, the released liquids were impregnated in the paper, and they were considered as meat-free water. In addition, pressed meat area and liquid released, were determined following the Image J software (Image j® 1.40 g, Wayne Rasband, National Institutes of Health, USA). Water holding capacity was performed in triplicate and was determined using the following equation

$$\text{Water release} = \frac{(\text{total surface area} - \text{meat layer area})\text{cm} \times 61.1 \times 100}{\text{Total moisture of meat sample (mg)}} \quad \text{……………………… equation 1}$$

$$\text{WHC} = 100 - \%\ \text{free-water} \quad \text{…………. equation 2}$$

Texture Profile Analysis

A Texture Analyzer (TA.XT2/ Plus Upgrade, Stable Micro Systems, Surrey, UK) with a two-bite compression setup was used to assess the textural characteristics of the sausage for adhesiveness, gumminess, resilience, hardness, springiness, cohesiveness and chewiness. The Texture Analyzer was equipped with a cylindrical probe of 36mm.The mechanical test conditions included a 50% compression rate,5mm/s of cross head speed for the pretest, test, and post- tests speeds, and 5g of automatic trigger load. The samples were cut into slices which were 12.5mm thick and 26mm in diameter, and the measurements were carried out 16 times for each treatment. The parameters extracted were: hardness (maximum force of the first compression), springiness (distance of the detected height during the second compression divided by the original compression distance; distance 2/distance 1), cohesiveness (area of work during the second compression divided by the area of work during the first compression; area 2/area1), chewiness (hardness × cohesiveness × springiness), and resilience (calculated by dividing the up stroke energy of the first compression by the down stroke energy of the first compression; area4/area3).

Sensory Analysis

All participants were volunteers solicited from the Department of Animal Science Kwame Nkrumah University of Technology (KNUST) Kumasi, Ghana. The participants were presented with three digit randomly coded samples. Each preparation was evaluated for consumer acceptability using a 9-point hedonic scale (9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4= dislike slightly, 3 = dislike moderately, 2 = dislike very much, 1= dislike extremely). Forty-five (45) untrained participants evaluated the fresh sausage for acceptability of appearance, color, tenderness, flavor, after taste, mouth feel and overall liking. Participants were required to cleanse their palates with biscuit and water between tasting the samples.

RESULTS

Physico-chemical analysis

The physico-chemical properties of GPWL substituted frankfurter (Table 2) revealed that there were no significant differences (P>0.05) among the pH of the emulsion and pH of the cooked product. The pH of the emulsion ranges from 5.64 to 5.69 while that of cooked frankfurter ranges between 5.79 and 5.88. The cooking loss of T_5 (27.61) and T_4 (18.75) were significantly higher (P<0.05) than T_3 (14.19), T_2 (14.36) T_1 (13.12). The water holding capacity of the control T_1 (16.30) and T_2 (15.00) were significantly higher (P<0.05) than T_3 (14.60) T_4 (12.20) T_5 (13.70).

Table 1: Ingredients formulation of frankfurter with graded level of Palm weevil larvae

	Graded levels of Pam weevil larvae				
GPWL (%)	0	5	10	15	20
Ingredients (g)	T_1	T_2	T_3	T_4	T_5
Ground meat	700	665	630	595	560
GPWL	0	35	70	105	140
Pork fat	100	100	100	100	100
Ice	150	150	150	150	150
Curing salt	15	15	15	15	15
Phosphate	5	5	5	5	5
Spices *	30	30	30	30	30
Total	1000	1000	1000	1000	1000

GPWL= Grounded Palm Weevil Larvae; spices curry, red pepper, onions and garlic (all in powder)

Table 2: Physicochemical characteristics of frankfurters incorporated with graded levels of palm weevil larvae

	Graded levels of Palm weevil larvae					
GPWL (%)	0	5	10	15	20	
Parameters	T_1	T_2	T_3	T_4	T_5	LSD
pH of emulsion (raw)	5.64	5.69	5.68	5.69	5.72	0.55
pH of cooked frankfurter	5.79	5.83	5.88	5.85	5.82	0.55
Cooking loss (%)	13.12[c]	14.36[c]	14.19c	18.75[b]	27.61[a]	0.55
WHC	16.30[a]	15.00[a]	14.60[ab]	12.20[b]	13.70[b]	1.20

*[a, b, c] Means with different superscript on the same row are significantly different (P<0.05), WHC = Water Holding Capacity

Nutrient composition

The moisture content (62.30) of 70% pork was significantly higher (P<0.05) than 56.35, 54.55, 49.00, 46.20 obtained for 5%, 10%, 15% and 20% GPWL frankfurters, respectively. The crude protein content (10.64%) of the 70% pork frankfurter was significantly lower than all the GPWL frankfurters and the values were 14.72%, 18.18%, 16.51% and 16.40% for 5%, 10%, 15% and 20% GPWL substitution frankfurter, respectively. The ash content of 70% pork (6.50) and 5% GPWL frankfurter (6.60) were similar (P>0.05) but significantly lower (P<0.05) than 7.50 (10% GPWL frankfurter) and significantly higher (P<0.05) than 5.04 (15% GPWL) and 5.30 (20% GPWL frankfurter). The ether extract of 18.40 (70% pork), 18.90 (15% GPWL frankfurter) and 19.40 (20% GPWL frankfurter) were significantly higher (P<0.05) than 16.10 (5% GPWL) and 17.10 (10% GPWL). There was no significant difference (P>0.05) in the crude fibre of 15% (0.32) and 20% (0.34) frankfurter but these were significantly (P<0.05) higher than 0.12 (70% pork), 0.18 (15% GPWL) and 0.25 (20%) frankfurters.

Table 3: Nutrient composition of frankfurter substituted with graded levels of palm weevil larvae

	Graded levels of Palm weevil larvae					
GPWL (%)	0	5	10	15	20	
Parameters %	T_1	T_2	T_3	T_4	T_5	LSD
Moisture	62.30[a]	56.35[b]	54.55[b]	49.00[c]	46.20[c]	2.00
Ash	6.50[b]	6.60[b]	7.50[a]	5.04[c]	5.30[c]	0.18
Crude protein	10.64[c]	14.72[b]	18.18[a]	16.51[b]	16.40[b]	0.22
Ether extract	18.40[a]	16.10[c]	17.10[b]	18.90[a]	19.40[a]	1.02
Crude fibre	0.12[d]	0.18[c]	0.25[b]	0.32[a]	0.34[a]	0.02

*[a, b, c] Means with different superscript on the same row are significantly different (P<0.05)

Texture profile analysis

The Texture Profile Analysis (TPA) (Table 4) showed that there was no significant difference (P>0.05) in the hardness (47.99kg) of 70% and 5% GPWL (47.55kg) frankfurter but these were significantly lower (P<0.05) than 48.51kg (T_3), 49.27kg (T_4) and 49.61kg (T_5). The chewiness of T_1(1.15) and T_2 (1.17) were not different (P>0.05) but these were significantly lower (P<0.05) than 1.69 (T_3), 2.07 (T_4) and 2.07 (T_5). The adhesiveness (0.10-0.17kg/sec) and cohesiveness (2.03-3.10kg/sec) obtained in this study for GPWL based frankfurter were significantly lower (P<0.05) than 0.24kg/sec (adhesiveness) and 0.85kg/sec (cohesiveness) recorded for the control frankfurter. The springiness (1.57mm) of 70% pork frankfurter was significantly (P<0.05) lower than all the springiness (2.08-2,96mm) of the GPWL frankfurter. The gumminess of 10% (1.43N), 15% (1.35N) and 20% (1.46N) GPWL frankfurters were significantly higher (P<0.05) than 5% GPWL (0.93) and 70% pork (0.42). The resilience (0.66) of 10% GPWL frankfurter was significantly higher (P<0.05) than 0.08 (70% pork), 0.12 (5%), 0.21 (10%) and 0.20 (15%) GPWL frankfurters.

Sensory Qualities

The sensory qualities as displayed (Table 5) showed that the appearance (7.38; 6.88), flavour (6.96, 6.80), tenderness (6.80, 6.48) and acceptability (7.56, 7.16) of 70% pork and 5% GPWL frankfurters respectively are significantly (P<0.05) higher than 5.40, 4.88, 4.36 (appearance); 5.72, 5.32, 4.64 (flavour); 6.28, 5.80, 5.28 (tenderness) and 5.20, 4.68, 3.96 (acceptability) obtained for 10%, 15% and 20% GPWL frankfurter, respectively.

The mouth feel (7.24) of 70% pork is significantly (P<0.05) higher than 5.60 (15%) and 4.58 (20%) GPWL frankfurters but similar to 6.52 (5%) and 6.20 (10%) GPWL frankfurter. The after taste 4.60 (70%pork) and 4.84 (5% GPWL) frankfurters were significantly (P<0.05) lower than 5.76 (10%), 6.92 (15%) and 7.16 (20%) frankfurters. However, the juiciness of 70% pork (6.36), 5% GPWL (6.20) and 10% GPWL (6.16) were similar but significantly (P<0.05) higher than 15% GPWL (5.80) and 20% GPWL (5.68) frankfurters.

Table 4: Texture profile analysis of frankfurter substituted with palm weevil larvae

	Graded levels of Palm weevil larvae					
GPWL (%)	0	5	10	15	20	
Parameters	T_1	T_2	T_3	T_4	T_5	LSD
Adhesiveness kg/sec	0.24^a	0.11^c	0.16^b	0.10^c	0.17^b	0.02
Chewiness (Nmm)	1.15^c	1.17^c	1.69^b	2.07^a	2.07^a	0.08
Cohesiveness kg/sec	0.85d	3.00^a	2.03^c	2.17^b	3.10^a	0.75
Gumminess (N)	0.42^c	1.43^a	0.93^b	1.35^a	1.46^a	0.30
Hardness (kg)	47.99^b	47.55^b	48.51^a	49.27a	49.61^a	2.36
Resilience	0.08^b	0.12^b	0.21^b	0.66^a	0.20^b	0.14
Springiness (mm)	1.57^d	2.74^b	2.96^a	2.08^c	2.09^c	0.24

$*^{a, b, c}$ Means with different superscript on the same row are significantly different (P<0.05)

Table 5: Sensory characteristics of sausage as influenced by graded level of palm weevil larvae inclusion

	Graded levels of palm weevil larvae					
GPWL (%)	0	5	10	15	20	
Parameters	T_1	T_2	T_3	T_4	T_5	LSD
Appearance	7.38^a	6.88^a	5.40^b	4.88^{bc}	4.36^c	0.30
After taste	4.60^c	4.84^c	5.76^b	6.92^a	7.16^a	0.30
Flavour	6.96^a	6.80^a	5.72^b	5.32^b	4.64^c	0.50
Tenderness	6.80^a	6.48^a	6.28^{ab}	5.80^b	5.28^b	0.50
Juiciness	6.36^a	6.20^a	6.16^a	5.80^b	5.68^b	0.40
Mouth feel	7.24^a	6.52^{ab}	6.20^{ab}	5.60^b	4.48^c	0.04
Acceptability	7.56^a	7.16^a	5.20^b	4.68^{bc}	3.96^c	0.60

$*^{a , b, c}$ Means with different superscript on the same row are significantly different (P<0.05)

DISCUSSION

There was a slight change in the pH of the cooked frankfurter compared to that of emulsion. The increase in the pH could be attributed to increased salt concentration due to loss of moisture (cooking loss) and the change in the net charge of proteins due to denaturation (Babu *et al.,* 1994). Substitution with GPWL was observed to cause slight change (although no significant difference) in pH when compared with frankfurter with 70% pork. This implies that its addition causes a change in pH of the frankfurter which is accordance with Suman Talukder (2015) that addition of fiber causes change in pH of meat products. The pH of the emulsion and cooked PWL frankfurter obtained in this study falls within the values of 5.86 (raw emulsion) and 5.57-5.79 (cooked sausage) obtained by Méndez-Zamora *et al*. (2015) but lower than 6.21-6.30 reported by Grizotto *et al*. (2012) for okra flour inclusion sausage.

The GPWL addition had an inverse relationship with WHC and a direct relationship with cooking loss implying that the loss due to cooking increases while the WHC decreases as the addition of GPWL increases. This could be attributed to the high fat content of the product as a result of the addition of GPWL which is high in fat (Rumpold and Schluter, 2013) which on heating will melt and result in cooking loss.

The nutrient composition of GPWL substituted frankfurter revealed that moisture contents of the GPWL frankfurter decreases with GPWL substitution. The low moisture content could be ascribed to the deceasing water holding capacity and increasing cooking loss (Table2).

Protein content is an indicative of nutritional quality of a product (Naveen *et al*., 2016). The high crude protein content of GPWL frankfurter recorded in the present experiment might be due to the high protein contributed by PWL (25.04%) (Rumpold and Schluter, 2013), 30.46% Anankware *et al*., 2015). It might also be attributed to decrease in water content (moisture) which causes increase in concentration of the protein (Carlos *et al*., 2009). It would have been expected that the ether extract of GPWL substituted frankfurters would increase with the inclusion of GPWL because of the high fat content (22.24% Anankware *et al*., 2015; 50.23% Rumpold and Schluter, 2013) of PWL. However, a lower ether extract was observed up to 10%GPWL substitution after which the fat starts to increase. However, the reverse is observed with the ash and crude protein contents of the GPWL frankfurters. These nutrients increase up to 10% substitution level after which they start to decline. The decrease in these nutrients could be as a result of high cooking loss of the frankfurter after 10% substitution because a high cooking loss denotes loss nutrients.

Some of the protein values for GPWL-based frankfurter obtained in this study fall within the range of 14.30-18.40% and 15.00-16.50% while their fat contents were higher than 8.70-13.90% and 8.60-11.70% for chicken and duck substituted frankfurter, respectively (Namrye Lee *et al.* 2018). However, the protein and fat contents of the GPWL frankfurter in this study are higher than 14.20- 16.22% (protein) and 10.74-11.60% (fat) obtained by Wan Rosli *et al*. (2015) for chicken frankfurter substituted with mushroom powder. The nutrients profile of GPWL frankfurters of this study were also higher than 13.42-13.98% (protein), 16.22-17.04% (fat) and 2.83-2.88% (ash) but lower than 61.87-62.42 % (moisture) reported by Grizotto *et al*. (2012) for sausage containing okra flour.

The texture parameters reflected a progressive hardening of the product although the difference was not noticed until after 5%GPWL substitution. The increase in hardness could be explained in terms of the moisture content and water holding capacity of the product which decreases as the substitution level of GPWL increases. More water is lost which brings about the low moisture content resulting in increased hardness and consequently increased chewiness (number of chews before swallowing). This indicates that there is a connection between hardness and chewiness. Again, a greater protein concentration (as observed in the study) in the matrix may entail increase in firmness (hardness) (Park, 2000) because protein contributes to firmness of meat products (Heinz and Havzinger, 2007). The increased hardness and chewiness values of GPWL frankfurters could also be attributed to the increase in crude fibre contents (carbohydrate) (Huang *et al.*, 2005, Huda *et al.*, 2010b). The increase in hardness is also reflected in the decrease tenderness of the product especially at 15% and 20% GPWL substitution.

The springiness of GPWL-based frankfurters was higher and this same trend was observed by Wan Rosli *et al*. (2015) who reported an increase in springiness of frankfurter when mushroom was used as substitute. The high springiness could be as a result of the cooking process which could have led to some modifications in their structure. This was also observed by Wan Rosli *et al*. (2011) when oyster mushroom powder was added to patties. The present observation slightly followed the trend reported by Garcıa *et al*. (2002) that low fat sausages with added cereal fibre (3% addition) were harder, less elastic and less adhesive.

Consumers are the ultimate users of a meat product therefore their perception and eating satisfaction is of paramount importance for the success of any meat product. Most of the sensory parameters decrease as the substitution of pork with GPWL and the panelist rated the 70% pork and 5% GPWL frankfurter as the best and most preferred. This indicate that substitution with GPWL affected the sensory characteristics of the frankfurter.

The appearance which is an important parameter which influences consumer's inclination when buying becomes less appealing as GPWL substitution level increases. This might be that the characteristic pink colour expected of a processed meat product like frankfurter has gradually disappear as the substitution level increases. This might be due to the fact that each consumer has his/ her expectations of how a particular food should look like (Maina, 2018) and consumers use visual cues to judge the quality of food they are meant to eat (Endrizzi *et al*., 2015)

Palatability of meat products depends upon the qualities like aroma and flavour, tenderness, colour and juiciness. However, research have shown that texture and tenderness is of utmost importance among all the attributes of eating quality for the overall acceptability of meat products (Talukder, 2015).

The decrease in juiciness, flavour and tenderness of the product as GPWL inclusion increases could be attributed to the decreasing moisture (Table 3) and water holding capacity (Table 2) of GPWL frankfurters. Although fat is one of the components that contributes to flavour and juiciness of meat products, however, the inherent moisture of the products also plays an important role. This is because juiciness, tenderness and flavour of meat product is directly associated/ linked to water holding ability (inherent moisture), the more a product can hold onto its water the juicier and tender the product. The decrease in tenderness is also reflected in the increased hardness and chewiness of the product as the degree of tenderness is evaluated as the number of chews required to masticate the product thus the increased chewiness due to hardness.

CONCLUSION

The partial replacement of pork with Palm weevil larvae in frankfurter has a positive effect on its nutrient profile. It is therefore possible to use palm weevil larvae to produce frankfurter of acceptable sensory characteristics. However, the partial replacement with Palm weevil larvae in frankfurter production should not exceed 10% in order to achieve the necessary good qualities expected of frankfurter.

CONFLICTS OF INTEREST

The authors affirm that there was no conflict of interest

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