

Production and Quality Evaluation of Novel Insect-Based Snack (Rhyncho-Roll) for Human Consumption

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Abstract

Recipe of African palm weevil larvae (APWL) (Rhynchophorus phoenicis) was processed with common ingredients (vegetable oil, onion, pepper, salt, maggi, tomatoes and little quantity of dried crayfish), was used as a filler to produce a novel snack called "Rhyncho-Roll" (RR). The nutritional value of Rhyncho-Roll was determined and compared with a commonly consumed snack called Gala (GL). Proximate composition of Rhyncho-roll and Gala revealed higher content of fat for Rhyncho-roll (55.90%:6.55%), protein (7.8%:6.55%), ash (5.75:4.15%) and moisture (18.30%:16.65%) respectively. Gala was higher than Rhyncho-roll in carbohydrate (42.64%:7.87%) only. Total energy value of Rhyncho-Roll was 604.086kcal/100g which was more than twice the total energy value of Gala (270.205Kcal/100g). Mineral composition of Rhyncho-roll and Gala showed that both snacks possessed almost equal amounts of Iron (7.1:7.4mg/100g), sodium (208:209mg/100g), potassium (1.152:1.982mg/100g), zinc (2.39:3.69mg/100g) and calcium (2.2:4.2mg/100g) in that order, Rhyncho-Roll had trace amounts of magnesium (0.05mg/100g) and fair in phosphorus (11.53mg/100g); whereas Gala had fair amounts of magnesium (7.45mg/100g) and phosphorus (19.67mg 100g), Fatty acid composition of Rhyncho-roll was predominantly polyunsaturated fatty acids (PUFA) which comprised of linolenic acid (33.16%) omega-3 and linoleic acid (7.5%) omega-6 which are recommended for healthy function of the human heart. Gala had lower amounts of PUFA: linolenic acid (0.45%) omega-3 and linoleic acid (11.05%). and higher percent in oleic acid (43.13%), trace amounts of palmitic acid (0.13%) omega combined palmitoleic acid (0.67%) omega-7 which are monounsaturated fatty acids (MUFA), Rhyncho-roll contained fair amounts of oleic acid (15.61%) omega-9. Gala had higher amounts of stearic acid (41.76%), and lower in palmitic acid (3.12%) and NI (0.36%) which are saturated fatty acids (SFA) that are not good for human health. Rhyncho-roll was lower in three saturated fatty acids: palmitic acid (25.64%), stearic acid (11.26%) and arachidonic acid (2.40%). Sensory evaluation showed that Rhyncho-roll had higher acceptability of 8.55, while Gala had lower acceptability of 7.75. results of other organoleptic properties showed that Rhyncho-roll was better than Gala in texture (8.55: 7:75), flavor (8.20:7.35), taste (8.20:7.60) and colour (8.05:7.08). LSD test confirmed that the differences in the observed means was significant ($P < 0.05$) for texture and flavor. Rhyncho-roll, is better than Gala which is in the market this was the preliminary phase of developing a novel food product..

Keywords: *R. phoenicis*, larvae, Rhyncho-roll and Gala **Explanatory notes:** APWL= African Palm Weevil Larvae, RR = Rhyncho-rolls, GL = Gala (Beef Sausage Roll), PUFA = Polyunsaturated Fatty Acid, MUFA = Monounsaturated Fatty Acid, SFA = Saturated Fatty Acid, LSD = Least Significant Difference.

Introduction

Many people in developed countries consider insects as food for its novelty than the nutrients, as in cases where insects are consciously embedded in chocolates or ice cream (Johnson, 2010). At other times, insects are regularly eaten as means of survival during periods of famine, hunger or drought arising from environmental crises (Yoshimoto, 1999). However, in Japan, insects are eaten as part of their traditional diets (Nonaka, 2010). Earlier studies have shown that insects remain preferred food which provides supplementary source of proteins, fat, minerals and vitamins in various cultures of the world (Durst and Shono, 2010). Some edible insects have nutritional values that can be compared to meat and fish, while others have higher proportion of proteins, fat and energy value (Defliort, 1992 and Banjo et al, 2006). There are also several rural communities and cultures in Zimbabwe, Zambia, South Africa, Ghana and Nigeria, where many families make fairly good living from selling of insects (Chavunduka, 1975; Fasoranti and Ajiboye 1993). In tropical countries, insects are often consumed whole, but grasshoppers and locusts require the removal of the legs or wings before being processed by roasting, frying or boiling. In the Lao People's Democratic Republic, insects are usually found in the markets as ready-to-eat snacks with lime leaves (Aguila-Miranda *et al*, 2002). Currently, edible insects are being processed into more palatable forms by being ground into pastes, in the same way as meat is processed into products like hamburgers and hot dogs. In Thailand and the Lao People's Democratic Republic, Chili paste with crushed and ground giant water bugs (*Lethocerus indicus*) is a very popular traditional food known locally as "jeaw meang-da". Studies in Germany reported that Timo Backer and Christopher Zeppenfeld collaborated with sports scientist, Daniel Falkner to create a neutral-looking snack bar (made up of dried crickets and caterpillars) which could be marketed to sportsmen, who needed enough insect proteins that are ideal for the purpose of sporting activities. Therefore, they are currently in the process of crowd funding their "swarm" bar which is made-up of ground crickets which comes in the form of flavoured Red berries known as, "Chia Hazelnut" and "Raw Cacao". They have already obtained high-profile support from the Federal Ministry for Economic Affairs and Energy, as well as from the European Social Fund in Germany (Dossey *et al*, 2016). In addition, there is also considerable political interest in persuading Germans to overcome the reluctance to try this new, but unfamiliar food. Therefore, it is noted that in societies where consumers are not accustomed to eating whole insects, processed forms may be better accepted, as it was being introduced in Germany (Constance and Chris, 2017). Recently, the Institute of Food Technologists promotes the applications of Food Science and Technology in the development of new products with the aim of improving the quality of life of people in developing countries. The first prize of the competition was awarded during-the Annual Food Expo in Anaheim. United States, in June 2009, which went to the SOR-Mite project, which was a sorghum mixture enriched with termites. The nutritionally weak sorghum been consumed frequently in many African countries, is low in protein, fat and lacks several essential amino acids (such as lysine). For this reason, fortifying the sorghum with highly nutritious flying termites made much sense because the fermented new food produce been mixed with termites can be consumed as porridge at breakfast, lunch or dinner depending on local preferences. The advantages of this product, is the availability of all the raw materials easily sourced locally (Institute of Food Technology, 2011). Similarly, since the African Palm weevil larvae are popularly consumed as a traditional delicacy amongst many tribes in Africa, Asia and now Europe. Considering the fact that edible larvae of *Rhynchophorus* spp. are among the richest source of unsaturated fatty acids and high energy

value (2348.9KJ/100g of larvae); possession of high quality proteins, vitamins and minerals (Oliveira *et al*, 1976). Therefore, the objective of this study was to process the edible larvae of *R. phoenicis*, in combination with other common ingredients and carbohydrate to produce a "novel snack" that can be compared with the popularly consumed "Gala" in terms of its nutritional value and acceptability by consumers. This was in line with the advocacy by Food and Agriculture Organization (FAO) which craves for increased utilization of insects to bridge the deficiency gap for proteins and other essential nutrients needed by the increasing human population by 2050 (van Huis *et al*, 2013).

Materials and Methods:

Sources of larvae: The *R. phoenicis* larvae used in this study were obtained by harvesting wild infested raffia palms (*Raffia hookeri*) and oil palms (*Elaeis guineensis*) of the swampy tropical rainforest of Choba in Port Harcourt, metropolis Rivers State; and Anyama-Ijaw community of Southern-Ijaw LGA of Bayelsa State, all belonging to the palm belt of the Niger Delta, Southern Nigeria.

Preparation of Recipe: The recipe was prepared following the method used in earlier studies, Thomas *et al*, (2006). The larvae of *R. phoenicis* were knocking-down in ice and became inactive. 30g weight of the larvae was weighed using an analytical weighing balance. The amounts of the various ingredients (Table 1) were taken and put together in a grinding machine. Then, 20ml of water was added before it was ground into a paste. An empty frying pot was put on flame; the refined vegetable oil was first put into the frying pan and heated for 2 minutes and brought out of the flame. Then, the mixture of the ground larvae containing all the ingredients was poured into the pot and placed on the flame again and cooked with gentle stirring for proper blending within 3-5 minutes

Table 1: Composition of Recipe of *R. phoenicis* larvae

Samples	Qty of larvae (g)	Crayfish (g)	Maggi (g)	Salt (g)	Onion (g)	Pepper (g)	Tinned tomato (g)	Vegetable oil (ml)	Water (ml)
Product A	30	1	0.5	0.5	8.03	2.31	3.62	10	20
Product B	30	1	0.5	0.5	8.03	2.31	3.62	10	20

Key: A= Rhynco-Roll, B = Gala (Sausage Roll): Source: Thomas *et al*, (2006)

Preparation of Wheat Dough: During the preparation, 250g of wheat flour was weighed using an analytical weighing balance and put into a bowl. 100g of margarine plus 1g of baking powder and 0.5g of salt was added into the flour and mixed thoroughly manually until it looked like bread crumb. Later, 2-3ml of water was added bit by bit until a non-sticky smooth dough was formed, which was allowed to rest for 10mins in the bowl. Thereafter, little quantities of dry dough was sprinkled on a clear work surface for easy kneading of the dough for a short time and allowed for 5 minutes. The dough was rolled-out using a rolling pin in a rectangular pattern to form sausage roll of about 3mm thick. Then, the prepared recipe of *R. phoenicis* larvae was used as a filler at the edge of the prepared dough. The end portion which contained the recipe was carefully lifted up to cover the recipe (filler of Rhynchophorus larvae three times and stressed

out properly. A sharp table knife was used to cut the sausage into desired lengths and placed on a baking tray that was cleaned, greased and grazed with some margarine before been baked in a pre-heated oven at 150°C for 45mins to form a "**Rhyncho-Roll**" that appeared light brown in colour.

Sensory Evaluation: A panel comprised of thirty (30) students and staff of the department of Food Science and Technology (Rivers State University, Port Harcourt in Nigeria) who were served with the two products (labeled A and B) in two different white plates on a dining table, in a well lightened room. Each member of the panel was provided with a score sheet to evaluate the products based on their sensory characteristics of colour, taste, flavour, texture and overall acceptability of each product. Water was also provided for panelists to wash their mouths after eaten the first sample A, before they eat the second sample B, which were evaluated using a 9-point hedonic scale.

Chemical Composition: The chemical compositions of the two products (A&B) were determined by AOAC (2012) standard methods. Moisture determination was by oven-drying method, ash content was obtained through the use of muffle furnace (450-600°C). Kjeldahl method was used for protein determination, while carbohydrate was determined by the difference. The Energy values were calculated using the Athwart factor 4.0 for carbohydrate and crude fibre; 4.1 for protein and 9.0 for lipids (Fox and Cameron, 1989). Atomic Absorption spectrophotometer (AAS) techniques were used for the determination of seven essential mineral elements of the samples (Pomeranz and Meloan, 1971). Fatty acid profiles of the two products (A & B) were analyzed through gas chromatography (Model 7890A Agilent, USA) with flame-ionization detector (FID). The individual fatty acids in the oils were determined using the A.O.A.C. (2012) methods. Fatty acid methyl esters (FAME) were prepared from the extracted oils in 50ml round bottom flasks. 50mg of each sample was kept in separate flasks and 3ml of methanolic sodium hydroxide solution (0.5mo1/1 /solution of NaOH in methanol) was added. The reaction medium was refluxed for 10mins; 3ml of acetyl chloride was added; mixture was refluxed again for 10 minutes and then cooled to ambient temperature; 8ml hexane and 10ml of distilled water were added and allowed to stand for 5min to establish a top phase solution. The upper organic phase was recovered into a vial for GC analysis.

Identification and Quantification

Identification of individual fatty acids was based on comparison of the retention times and chromatographic profiles measured in the sample, with the retention times and profiles shown in the chromatograms of the (external) standard oils. The content of individual fatty acid was expressed as a percentage of the total content of all acids in the sample.

Results and Discussion

The results of the sensory evaluation (Table 2) showed that the new product Rhyncho-roll which was prepared with the recipe of *R. phoenicis* larvae had higher acceptability of 8.56, percent while Gala had lower acceptability of 7.75. The difference between those two means was significant at $P < 0.05$. The results also showed that Rhyncho-roll also had better flavor and texture than Gala because the Rhyncho-roll had mean score of 8.30 for flavor and 8.20 for texture, whereas Gala had lower mean scores of 7.35 and 7.30 for flavor and texture,

respectively. Rhyncho-roll equally had higher mean scores of 8.05 and 8.20 for colour and taste, respectively, while Gala had lower scores of 7.80 and 7.60 for colour 8.05 and 8.20 for color and taste, respectively. However, the difference in the means were not significant for both colour and taste, but there was significant difference in the means for flavor and texture in favor of the Rhyncho-roll.

Table 2: Mean scores for Sensory Evaluation of Ryhcho-Roll and Gala

Sample	Colour	Taste	Flavor 3	Texture 2	1 acceptability
Product A	8.05 ^a	8.20 ^a	8.20 ^a	8.30 ^a	8.55 ^a
Product B	7.08 ^a	7.60 ^a	7.35 ^b	7.30 ^b	7.75 ^a
LSD	0.60	0.75	0.80	0.74	0.71

Proximate composition: The proximate composition of Rhyncho-roll and Gala showed that the novel sausage roll made with the recipe of edible larvae of *R. phoenicis* known as “Rhyncho-Roll” was found to have very high fat content of 59.09, when compared to Gala which had lower fat content of 6.55%. The novel product (RR) was also higher in mineral content of 5.75% and a moisture content 18.30%, whereas the Gala had lower mineral content of 4.15 and moisture content of 16.65 ± 0.5%, respectively. However, the popularly consumed Gala was found to be higher in carbohydrates content of 42.64% while the new product (Rhyncho-roll) had lower carbohydrate of 7.87% source, while the common Gala in the market uses others forms of flour from cereals (maize) or cassava.

Table 3: Proximate composition of Rhyncho-Roll and Gala

Sample	Moisture content (%)	Ash (%)	Fat (%)	Crude protein (%)	CHO (%)	Energy kcal/100g
Rhyncho – Roll	18.30 ± 0.2	5.75 ± 0.05	55.90 ± 0-70	7.87 ± 0.43	7.87 ± 0.18	604.086
Gala	16.65 ± 0.15	4.15 ± 0.15	6.55 ± 0.01	6.55 ± 0.01	42.64 ± 0.28	270.205

Values are means + SE of duplicate results

Mineral composition: The mineral composition of the Rhyncho-roll and Gala shown in Table 4 revealed that both snacks are good sources of irons as each of them provided almost equal amount of iron (7.1-7.4mg/100mg) which was very close to the recommended daily reference intake of 8.0mg/100mg of iron. This means that people who patronize any of those snacks will not suffer from iron deficiency which leads to anemia. These snacks are complementary sources of potassium because which lead to anemia. These snacks are complementary sources of potassium because Rhyncho-roll and Gala contained 1.512-1.982mg/100g potassium which potassium which combines with other sources of potassium rich food when eaten will satisfy the recommended dietary preference intake of 4, 700mg/100g for healthy living in humans. Rhyncho-roll and Gala are low sources of zinc (2.39-3.69/100g), calcium (2.2-43mg/100g), phosphorus (11.53-19mg/100g) and sodium (208-209mg/100g) respectively, because these amounts were so small as compared to the recommended daily reference intake of 1,000mg/100g calcium; 1,500mg/100g sodium, and 700mg/100g of zinc, respectively are supplementary

sources of zinc as they can contribute meaningfully towards meeting-up the recommended dietary reference intake of 11mg/100g zinc. Although Gala contained low amount of magnesium (7.45mg/100g), Rhyncho-roll was poor in magnesium because it contained 0.005mg/100g magnesium, which was obviously insignificant as compared to the recommended dietary intake of 400mg/100g magnesium.

Table 4: Mineral composition of Rhyncho-Roll and Gala (mg/100g)

Sample	Ca	Fe	Na	K	Mg	Zn	P
Product A (Rhyncho-Roll)	2.2	7.1	209.0	1,152	0.05	3.69	11.53
Product B (Gala)	4.3	7.4	208.0	1,982	7.45	2.39	19.67
Dietary reference intakes	1,000	8.0	1,500	4,700	400.0	11.0	700.0

Table 5: Fatty acid profiles of Rhyncho-Roll and Gala

s/no		Samples		Fatty acids	Saturation/Characterization
		A	B		
1.	C ₁₆ :0	25.64	3.12	Palmitic acid	saturated (SFA)
2.	C ₁₆ :1	0.67	-	Palmioleic acid	omega-7 monounsaturated fatty acids (MUFA)
3.	C ₁₈ :0	11.26	41.76	Stearic acid	saturated (SFA)
4.	C ₁₈ :1	15.61	43.13	Oleic acid	omega-9 monounsaturated (MUFA)
5.	C ₁₈ :2	7.50	11.05	Linoleic acid	omega-6 polyunsaturated (PUFA)
6.	C ₁₈ :3	33.16	0.45	Linoleic acid	omega-3 polyunsaturated (PUFA)
7.	C ₂₀ :0	2.40	-	Arachidic acid	saturated (SFA)
8.	C ₂₀ :1	-	0.13	Pallinic acid	monounsaturated (MUFA)
9.	C ₂₂ :	-	0.36		saturated (SFA)

Key: A = Rhyncho-roll
B = Gala
N = Not Identified

Fatty acid competition: The fatty acid profiles in Table 5 revealed that Rhyncho-roll was dominantly composed of (33.16%) linolenic acid (omega-3) and linoleic acid was 7.50% (omega-6) which combined to form total polyunsaturation of 40.66% essentials oils recommended for healthy function of the human heart; but can only be obtained from special foods including vegetables (flax and canola plus fresh salmon fish) because it cannot be synthesized by the human body (Harvard heart letter, 2018). The polyunsaturated fatty acids (PUFA) was complimented by 15.16% of oleic acid (omega-9) and trace amount of 0.67% palmideic acid (omega-7) which form total monounsaturation of 15.83% founds which are moderately beneficial to human health but lesser in quality to the polyunsaturated fats (Harvard Heart Letter, 2018). The high proportion of polyunsaturated fatty acids found in the Rhyncho-

roll was attributed to the addition of *R. phoenicis* larval recipe as filler in the production of the novel insect-based snack, Rhyncho-roll, Gala contained lower proportion of polyunsaturated fatty acids (PUFA) which consisted of 11.05% linoleic acid (omega-6) and trace amount of 0.45% linolenic acid (omega-3) which was lower than the amount in Rhycho-roll. However, gala had the highest proportion of monounsaturated fatty acids of 43.13% oleic acid (omega-9) and little amount of 0.13% palmitic acid. Furthermore, Rhyncho-roll had additional advantages of having lower level of saturation of 40.30% which comprised mainly of 25.64% steric acid and 0.36% unidentified fat; compared with gala which had higher saturation of 45.24% comprised mainly of 41.76% steric acid and 3.12% palmitic acid. This further attest to the fact that Rhyncho-roll produces less cholesterol, the gall and reduces blood pressure in hypertensive and diabetic patients. (Harvard Hospital nutrition source, fats NIH Medicine, Encyclopedia, fats). However, the high contain of fats contained in the Rhyncho-roll can be reduced by defatting process.

Conclusion

The findings of this preliminary study has confirmed that the novel shock called Rhyncho-roll which contained recipe of *R.phoenicis* larvae was a better product than the commonly consumed meat-based sausage roll called “Gala” in Nigerian market and other parts of the world. Rhyncho-roll was more nutritious with sweeter taste and higher acceptability to consumers than gala. Rhyncho-roll equally supplied higher calories (604.08kca/100g) of energy, while gala supplied less calories (270.205kcal/100g) of energy when consumed due to dominant composition of poly-unsaturated (PUPA) fats, which consisted of mainly of 33.16% of linoleic acid (omega-3) and 7.5% of linolenic acid (omega-6) plus oleic acid (15.61%) and palmioleic acid (0.61%) which are monounsaturated fatty acids (MUFA) to form over 56.682% of total unsaturated fats that is good for healthy living is humans. Therefore, the production and consumption of the Rhyncho-roll should be consciously publicized due to greater potential of improving the health status and longevity of lifespan of consumers, especially peopling heart related disease condition. It is recommended that there should be no addition of oil during preparation of the novel food. That will reduce the excessively high content and lower the total energy to acceptable levels. Further studies is ongoing to develop a standard novel food products for healthy consumption and marketing.

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