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Research Article

EFFECTS OF CATERPILLAR (*IMBRASIA OYEMENSIS*) AND FISH (*THUNNUS ALBACARES*) MEAL ON THE ORGANOLEPTIC CHARACTERISTICS OF BROILER MEAT IN CÔTE D'IVOIRE

Diomande Masse*., Beugre Grat Avit Maxwell and Niaba Koffi Pierre Valery

Department of Biochemistry and Microbiology, Agroforestry Unit, Jean Lorougnon Guede University, Côte d'Ivoire

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A B S T R A C T

The aim of this study is to evaluate the influence of caterpillar (*Imbrasia oyemensis*) and fish (*Thunnus albacares*) meals on the sensorial quality of broiler meat. This caterpillar meal (*Imbrasia oyemensis*) has been incorporated into chicken feed as a substitute for fish meal (*Thunnus albacares*)..The substitution rate was 0, respectively; 1/3; 2/3 and 3/3 in Ro diets; R33; R66 and R100. Four batches of 25 chickens (cobb 500) of 2 weeks of age were fed with these four rations during 5 weeks of experimentation. The thighs, wings and breasts of the 3 chickens slaughtered in batches were cut, fried in oil for 20 min at 150 ° C. The organoleptic quality of the chicken meat was evaluated by a jury. The sensory evaluation method of the samples was the hedonic test. The results of the chemical analysis of the two meals showed that the caterpillar (*Imbrasia oyemensis*) is richer in protein (53.57 ± 0.23% vs 38.56 ± 0.14%) that of fish (*Thunnus albacares*). It was poorer in ash (2.17 ± 1.41 vs 7.73 ± 0.09) than fishmeal. Results of the organoleptic quality of chicken meats, indicated that the color and taste did not undergo any significant changes. On the other hand, the increasing rates of caterpillar meal were slightly correlated with the smell of the meat and moderately with the firmness of the meat. Chenille odor and firmness increased with increasing rates of caterpillar meal in chicken rations. Mortality was not correlated with caterpillar meal levels in chicken diets. Thus the caterpillar (*Imbrasia oyemensis*) can be validly incorporated into the diet of broilers without the risk of significantly modifying the production and characteristics of the meat. It may be recommended to poultry farmers as an alternative source of protein for poultry in tropical countries.

INTRODUCTION

Côte d'Ivoire has been involved in industrial poultry farming for about ten years (Pousga *et al*., 2005). Domestic production can not meet growing demand, resulting in imports of poultry meat, which increased from 2,000 tons in 2000 to 14,000 tons in 2004 (Essoh, 2006). The issue of the supply of food inputs is nowadays even more crucial as we witness on the international market the rise in the cost of ordinary materials, especially protein raw materials, especially fishmeal (Doumbia, 2002). . Under these conditions, research and development of alternative and locally available food resources in chickens' diets should improve their productivity (Soniaya and Gueye, 1998). Among these alternative resources, are the edible insects. In fact, caterpillars are available and easily accessible in the forest zone and can be a source of protein and energy because of their nutritional qualities (Malaisse and Lognay, 2004).

Corresponding author: **Diomande Masse**
Department of Biochemistry and Microbiology, Agroforestry Unit, Jean Lorougnon Guede University, Côte d'Ivoire

Research in agronomy has been growing in recent years with regard to entomophagy, but the data acquired is still very limited. Animal feeding trials should help to clarify the quality of insect proteins. In Côte d'Ivoire, where there are several varieties of edible insects, no study has been devoted to the incorporation of caterpillar meal into the broiler diet, hence the interest of the present work.

The objective of this study is therefore to evaluate the effects of the incorporation of caterpillar meal (*Imbrasia oyemensis*) into the diet on the organoleptic characteristics of broiler meat

MATERIAL AND METHODS

Biological material

The biological material consisted of caterpillar (*Imbrasia oyemensis*) and fish (*Thunnus albacares*) meal (Fig.1 and Fig.2).

Fig 1 caterpillar meal (*Imbrasia oyemensis*)

Fig 2 Fish meal *(Thunnus albacares)*

Formulations of rations and experimental device

Four (4) experimental start-up type rations for broilers were formulated. These are the rations (R0, R33, R66 and R100) of Ivograin foods with different ingredients (corn, wheat bran, cottonseed and soybean meal, salt, vitamins, calcium phosphate have been kept constant). This feed was supplemented with caterpillar flour (*Imbrasia oyemensis*) and fish incorporated respectively at 0%, 33%, 66%, 100% as a substitute for fish meal (*Thunnus albacares*) usually used as the main source of protein in the diet. The feeding of broilers. The preparation consisted of manually mixing the quantities of the different raw materials chosen. In each bag of Ivograin food, 2 kg of caterpillar and fish meal in the alternative proportion of 0%, 33%, 66%, 100% were mixed in order to have a very homogeneous ration. Four (4) batches of 25 experimental broiler chickens, at a density of 10 subjects / m2 until the animals were slaughtered, were fed on the different formulas containing the variable proportions of caterpillar and fish meal.

Physico-chemical analysis of flours and chicken rations

In the laboratory, dry caterpillars bought at the big man market were milled in the blender. Moisture and ash levels of dried caterpillar meal were determined by the AOAC method (1995). The crude proteins were assayed according to the method of BIPEA (1976) using Kjeldhal. The fat was extracted according to the AOAC method (1995) using soxhlet. The carbohydrates were measured according to the method of Bertrand and Thomas (1910). The energy value corresponding to the available energy is calculated using the specific coefficients of Atwater and Benedict (1902) for proteins, lipids and carbohydrates.

Evaluations of the organoleptic characteristics of chicken meat

The tasting panel was made up of people randomly selected from the Jean Lorougnon Guédé University (Daloa), including men and women, students, teachers, guards and workers.

The thighs, wings and breasts of the 3 chickens slaughtered in batches were cut, fried in oil for 20 min at 150 ° C, in 0.5 liter of oil for the pieces of the three chickens from each diet with equal amounts of condiments for 20 min. The analysis of organoleptic characters focused on the thighs, wings and breasts. The taste, color, texture and smell of these different pieces were appreciated. Three trials were conducted per batch with people who had no information about our experiences. The method used was the sheets to be filled with crosses according to the four criteria of appreciation, the taste (sweet, fade, other), the smell (of burnt, fish, caterpillar), the texture (firm, supple, other), color (red, white, other) So, the people who received the samples of cooked meat, they marked, by a cross their appreciation of the taste, color, texture and smell of meat.

Statistical analysis of the data

The data collected at the end of the physicochemical characterization of the samples were subjected to statistical analyzes. Thus, a multidimensional analysis of variance was carried out in order to appreciate the existence of difference between the studied samples. In addition, analyzes of variance were also performed on these data. Multiple comparison tests (Tukey HSD) were conducted when the difference was found to be significant ($p < 0.05$) to separate the different samples. For these statistical treatments, the STATISTICA 7.0 software was used.

RESULTS

Chemical composition of caterpillar (Imbrasia oyemensis), fish (thunnus albacares), startup and growth rations

Caterpillar (*Imbrasia oyemensis*) meal has the same moisture and fat content as fish meal but is richer in protein than fishmeal. On the other hand, it is lower in ash than that of fish (Table 1).

For startup ration, moisture content is identical in rations R0 to R100. The rate of ash decreases as the rate of caterpillar increases in rations. The carbohydrate content is almost constant from R0 to R100. The energy value of the ration R100 is higher than that of the other diets which are substantially identical. The protein level gradually increases from R0 to R100 (Table 2).

For growth ration, the humidity level is constant in the rations. The rate of ash and fat decreases as the rate of caterpillar increases in rations. As for the protein content, it is low in the ration R0 (7, 07%) compared to other rations or it has a constant content. The carbohydrate content is low in the R33 ration (62.65%) and is higher in the other diets. The energy value decreases as the amount of caterpillar increases (Table 3).

Table 1 Chemical composition of fish and caterpillar meals

	Chemical composition (% MS)				
	Dry matter	**Moisture**	**Ash**	**Fat**	**Protein**
F m	95, 3± 0,32a	4,70 ± 0,11b	7,73 ± 0,09a	20,78 ± 0,24c	38,56 ± 0,14 a
C m	94,43± 0,33a	5,56 ± 0,33b	2,17 ± 1,41b	19,43 ± 0,27c	53,57 ± 0,23 b

a, b, c, means followed by different letters within the same column are significantly different (p < 0,05) ; Fm: fish meal; C m: caterpillar meal

Table 2 Chemical composition of Startup Ration

	Chemical composition (% MS)						
	Dry matter	**Moisture**	**Ash**	**Fat**	**Protein**	**Carbohydrates**	**Energetic value (kcal/100g)**
R0	93,88± 0,01 a	6,12 ± 0,01a	7,50 ± 0,11a	7,91 ± 0,09a	21,39 ± 0,30a	57,08 ± 0,39a	385,07 ± 0,42 a
R33	93,25± 0,33a	6,75 ± 0,33a	7,12 ± 0,08a	7,33 ± 0,10a	22,25 ± 0,14b	56,54 ± 0,66a	381,17 ± 1,18a
R66	93,98± 0,03a	6,02 ± 0,03a	6,42 ± 0,04b	7,24 ± 0,31a	22,67 ± 0,07b	57,65 ± 0,36a	386,17 ± 1,69a
R100	93,94± 0,02a	6,06 ± 0,02a	6,17 ± 0,04b	8,84 ± 0,14b	23,74 ± 0,07c	55,17 ± 0,14b	395,17 ± 0,62b

a, b, c, means followed by different letters within the same column are significantly different (p < 0,05)

Table 3 Chemical composition of Growth Ration

	Chemical composition (% MS)						
	Dry matter	**Moisture**	**Ash**	**Fat**	**Protein**	**Carbohydrates**	**Energetic value (kcal/100g)**
R0	93,5± 0,01 a	6,50 ± 0,01a	6,18 ± 0,08a	13,10 ± 0,11a	17,07 ± 0,24a	57,17 ± 0,07a	414,82 ± 0,25a
R33	93,62± 0,01 a	6,40 ± 0,02a	6,28 ± 0,04a	11,88 ± 0,21b	22,79 ± 0,27b	52,65 ± 0,51b	408,71 ± 0,84b
R66	93,66± 0,02 a	6,37 ± 0,03a	5,39 ± 0,13b	9,11 ± 0,25c	23,03 ± 0,07b	56,09 ± 0,06 c	398,51 ± 0,40c
R100	93,77 ± 0,03 a	6,28 ± 0,04a	4,75 ± 0,00c	7,70 ± 0,11d	23,39 ± 0,07b	57,89 ± 0,16d	394,41 ± 0,05d

a, b, c, means followed by different letters within the same column are significantly different (p < 0,05)

Sensory evaluations of broiler meat's

Having consumed dietary rations The meat of the chickens of all the treatments (R0 to R100) were recognized as white meats in general by the jury. (Fig.3). The R0 and R100 treatments have roughly the same sweet and juicy flavor unlike R33 and R66 which seem less appreciated by the jury (Fig.4). The characteristic smell of caterpillars was increasingly noted in meats when the amount of caterpillar increased in rations (from R0 to R100). (Fig.5). Meats became increasingly firm as the amount of caterpillar flour increased in rations (from R0 to R100) (Fig.6).

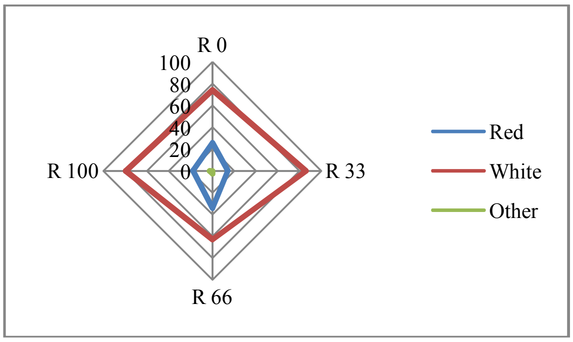

Fig 3 Effect of caterpillar meal rate on chicken meat color

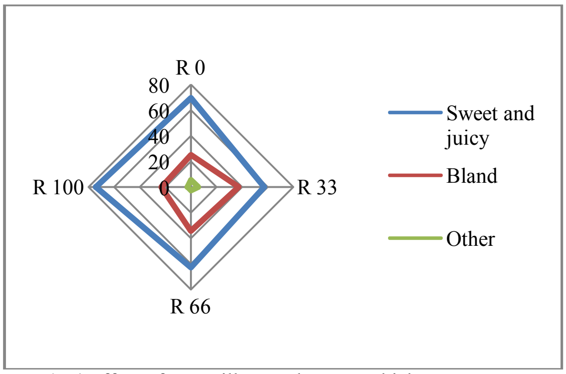

Fig 4 Effect of caterpillar meal rate on chicken meat taste

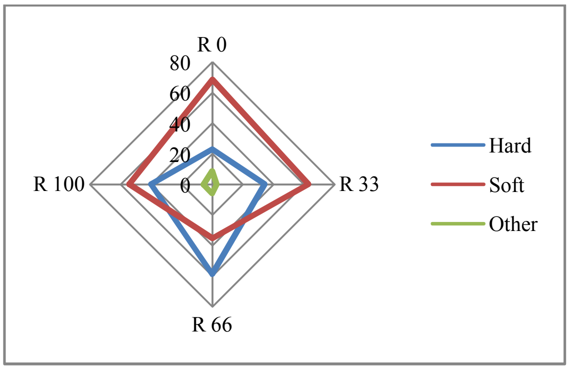

Fig.5 Effect of caterpillar meal rate on chicken meat texture

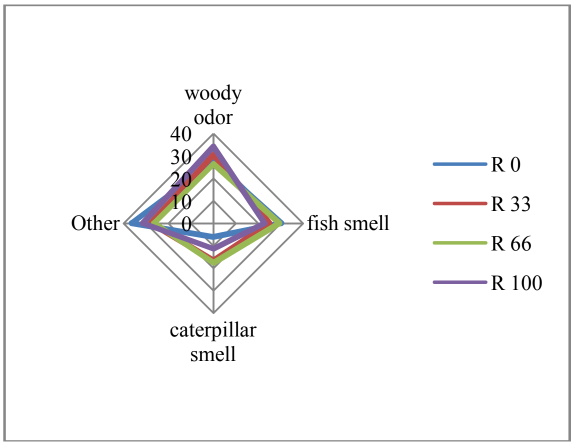

Fig 6 Effect of caterpillar meal rate on chicken meat smell

DISCUSSION

Caterpillar meal is an important source of protein (53.57%) for food and feed. Its protein content is lower than that of maggot (59.65%) and poultry by-product meal (61.54%) according to the work of Ouedraogo *et al*. (2015). This difference could be due to the way of heat treatment by the caterpillar by the peasant women who denatured the caterpillar. The protein levels obtained by this study are lower than those of the authors (Diomandé *et al*., 2008, Ouedraogo *et al*., 2015). These authors worked on snail meal (*Achatina fulica*) compared to that of fish in the chair in Côte d'Ivoire and on maggot meal and co-produced poultry in chicken feed in Burkina Faso. The different processing techniques of these flours and of nature are the reasons for these differences between the fish flour contents. The caterpillar flour has a low ash content which implies that its incorporation into the chicken feed rations must be accompanied by their mineral supplementation. Its fat content (19%) is similar to that of poison (20%) this study. This fat content is higher than that of fish (10%) and snail (4%) obtained by Diomandé *et al*. (2008). This result indicates that caterpillar meal can be used for fattening chickens (finishing).

The energy values and the protein contents of the rations of this study are higher than those of Abasse *et al*. (2017) and Kana *et al*. (2015). These authors worked respectively on moringa leaf meal oleifera and semolina residues of cassava supplemented with spirulina in the production of broilers. This difference could be related to the chemical composition of the ingredients used in the ration formulations.

The color of meat is the result of four components, the first two of which explain the color of the fresh product and the last two, its evolution during its conservation according to several authors. These components are, respectively, the degree of acidification (pH), myoglobin on the one hand, and reduced myoglobin and oxygen on the other (Normand 2005, Cartier and Moevi 2007). Chicken meat was generally recognized as white by the judging panel. This means that the caterpillar flour did not change the color of the chicken meats that are classified as white meats.

The flavor of the meat corresponds to the olfactory and taste impressions that one experiences at the time of the tasting. The various chemical compounds responsible for the flavor of the meat are released mainly at the time of cooking according to Lameloises *et al*. (1984). These same authors have shown that amino acids and fatty acids are part of the precursors of the flavor of meat. Protein and fatty acid values of caterpillar flours and fish could explain variations in meat flavor. Effect, meat from treatments R33 and R66 seem less appreciated than those having received a single type of animal flour (R0, R100). The combination of different protein sources would have an adverse effect on the flavor of chicken meat. However, statistical analysis showed that there is no significant difference between treatments. Juice or succulence characterizes the ability to exude meat at the time of tasting. It is the essential factor that influences the water retention capacity in water of the muscle (Lameloises *et al*., 1994). It translates the binding force between water and the proteins of the muscle fiber. Water retention depends on the spatial structure of muscle fiber proteins. The incorporation of caterpillar flour did not modify the juiciness of the meats resulting from the different treatments.

The texture of the meat is represented by its tenderness or its firmness. Tenderness is the ease with which meat is sliced and chewed, the opposite of hard or firm meat, difficult to chew. Several authors have shown that tenderness is the most important sensory quality for the meat consumer (Touraille, 1994). The incorporation of caterpillar flour causes a decrease in the tenderness of the meat and inversely leads to an increasingly increasing firmness of the meat. This result could be explained by the nature, structure and mode of transformation of the proteins of this caterpillar meal. Collagens are for example responsible for the rigidity of certain proteins as well as the prolonged heat treatment.

The caterpillar odor increased as the flour of this caterpillar increased in rations. This result confirms those of Touraille (1994) who have shown that the smell of animal meal is found in the meat of animals that have consumed it. The increased woody scent of the rations indicates that the caterpillar flour has undergone a prolonged heat treatment causing carbonization of the organic structures of the caterpillar flour samples during processing.

CONCLUSION

At the end of this study, it can be noted that caterpillar meal (*Imbrasia oyemensis*) was richer in protein than fish meal (*Thunnus albacares*). It was poorer in ash and therefore in minerals than fishmeal.

The color and taste of the meat have not been modified by the incorporation of caterpillar flour into the rations of the chickens. In contrast, the smell and fermented meat increased slightly with increasing caterpillar rates in rations.

Thus the caterpillar (*Imbrasia oyemensis*) can be validly incorporated into the diet of broilers as a substitute for fishmeal (*Thunnus albacares*) without the risk of modifying the production and characteristics of the meat. It may therefore be recommended to poultry farmers as an alternative protein resource for poultry in tropical countries.

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