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Infestation of a Complementary Food by *Tribolium Castaneum* Herbst Macleay 1825 (Coleoptera: Tenebrionidae)

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Abstract
During storage of complementary foods in the form of flour, secondary pests attacked including *T. castaneum*. To evaluate these depreciation two formulations were elaborated using infested insects in 1200 ml jars with 11 repetitions for each. After 90 days of infestation, emergences were noted. The average sizes of the different stages showed that the formulation with bambara groundnut was that which noted the most emergences. The average of stage I is 68.4 ± 26.3 in the formulation with bambara groundnut and 29.2 ± 14.1 in that without. The same is true for stage V and in the adults where the emergences respectively were 111.9 ± 45.3 and 397.2 ± 130.6 in formulation with bambara groundnut and 46.8 ± 15.6 and 164.7 ± 22.5 in the formulation without.

Key words: formulation, *T. castaneum*, storage, depreciation, infestation

Introduction

Flour, a product from grain milling, is one of the main calorie inputs of human nutrition. It is associated with flour from legumes that are a source of protein (Kouebou *et al*., 2013) for the constitution of high-nutrient infant supplement foods from six months of age (Cheftel and Cheftel, 1985). However, during its conservation it is damaged by several factors which at the origin of depreciation of its leptic and physical quality. The biotic factors that depreciate are mainly represented by certain Coleoptera species, in this case *T. castaneum* (Tapondjou *et al*., 2002), classified as a secondary pest (Ngamo *et al*., 2007). Insects consume particularly the protein matter of the flour and allow the products of metabolism. They also increase in a relative manner the starch rate, characterized by its great capacity to absorb water (Mbadja, 1989). The purpose of this work is to evaluate the depreciation of this insect on the complement food elaborated.

Material and methods

Permanent breeding of Tribolium castaneum

The insects come from the infested wheat flour bought from the market of Yagoua, Far North Region of Cameroon. In five glass jars of 1200 ml, with perforated lid, 200mg of rice flour are introduced, and then 20 adult insects are added. Ten days (laying time) after sieving, adults are removed from the jar to let the new generation evolve with ambient temperature.

Composition of the formulation

Two formulations were made from the bambara groundnut and rice flour as shown in Table 1. The first formulation consists of 15% bambara groundnut flour + 75% rice flour + 5% sugar and 5% peanut oil (Barennes, 2005). The second formulation without bambara groundnut which serves as the control consists of 90% rice flour + 5% sugar + 5% peanut oil. The food was weighed using a NOVA brand electronic scale 1g of precision.

Table 1. Composition of formulations with different proportions (%)

	Formulation with bambara groundnut	Formulation without bambara groundnut
Rice flour	75	90
bambara flour	15	0
Sugar	5	5
Oil	5	5
Final weight formulation	100	100

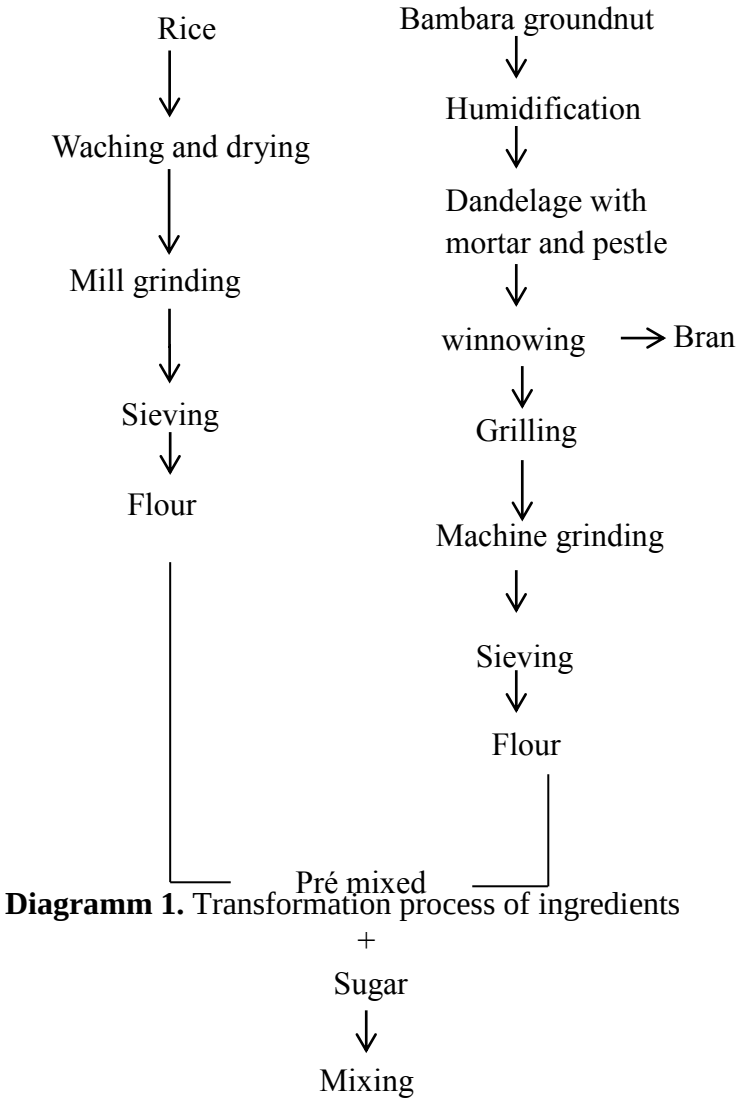

Diagramm 1. Transformation process of ingredients

Determination of infestation level

In 1200ml glass jars, 210g of the formulation were introduced with 11 replicates. Adults *T. castaneum* of the same stage development were added to each jar after differentiating the sexes. The first sieving took place after 10 days to remove adult insects. At 90 days of infestation the second sieving was done as well as the counting and also to evaluate the level of infestation and determine the different stages of development. The different larval stages were determined using a graph paper.

Statistical analysis

The statistical analysis was carried out by the Excel software for the calculation of averages and standard deviations of the different stages of development.

Results and discussion

90 days after infestation, all larval stages, nymphal, and adults are present in both formulations. The averages of the sizes of stage I to stage V of the formulation with bambara groundnut are greater than those of the formulation without. The same is true of the nymphal and adult stage. There is a significant difference ($P \leq 0.05$) between the averages for the Kolmogorov-Smirnov tests. Stages III, V and adults have average numbers greater than 100 for the formulation with bambara groundnut, while for formulation without only the number of adults is greater than 100 (Table 2). These would be due to the composition of nutrient-rich formulation with bambara groundnut. According to Delobel and Tran (1993), the number of eggs laid can vary according to the food in which they develop. Insect tolerances are stricter in finished commodities such as flour or cornmeal. The defect action level set by the Food and Drug Administration for insect and insect fragments is one or more whole insects per 50 grams or an average of 25 or more insect fragments per 25 grams (Food and Drug Administration 2009).

Table 2. Average workforce of both formulations

Stages of development	I	II	III	IV	V	nymphal	Adult
AB	68,4	81,9	100,7	68,8	111,9	55,9	397,2
Standard deviation	26,3	27,9	27,6	25,6	45,3	42,8	130,6
AEWB	29,2	38,5	47,0	35,5	46,8	13,9	164,7
Standard deviation	14,1	12,5	19,1	7,7	15,6	15,8	22,5

AB : average of effectives of formulation with bambara groundnut ; AWB : average of effectives of a formulation without bambara groundnut

From the averages of the data obtained a histogram has been plotted as shown in Figure 1.

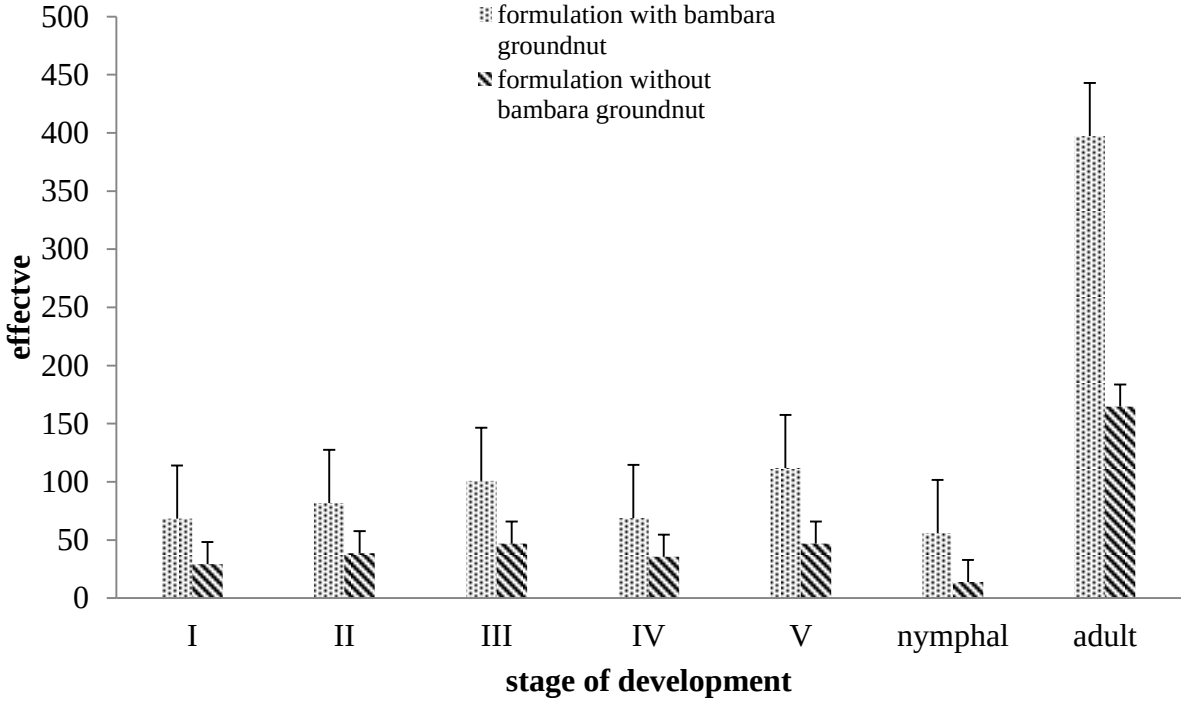

Figure 1. Infestation level by stage of development

Conclusion

The results show that there is favorable development of *T. castaneum* in the formulation with bambara groundnut according to the infestation level of the insect. This formulation is attacked more with the important emergences in all the larval stages and adult than the formulation without bambara groundnut. Hence there is need for conservation tool in order to preserve food and nutritional quality which provides a good role for complementary food for infants.

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