Research Journal of Animal Sciences 4 (5): 108-111, 2010
ISSN: 1993-5269


# Physico-Chemical Properties and Safety of Grasshoppers, Important Contributors to Food Security in the Far North Region of Cameroon

[1]Ahmed Ali, [2]Bouba Adji Mohamadou, [1]Clement Saidou,
[3]Yaouba Aoudou and [2]Clerge Tchiegang
[1]Department of Chemical Engineering,
[2]Department of Food Engineering and Quality Control,
University Institute of Technology Ngaoundere, Cameroon
[3]Department of Food Science,
National School of Agro-Industrial Sciences Ngaoundere, Cameroon

**Abstract:** This research was carried out to determine physico-chemical characteristics and microbial quality of grasshoppers widely consumed in the Far North region of Cameroon where they contribute to a significant extent to food security. To this effect, morphology, moisture content, fats, proteins, total ash, minerals and some heavy metals were analyzed for fresh and fried grasshoppers purchased in local markets. Their safety was assessed through pathogenic microorganisms (bacteria and yeasts) screening using standard methods. Results showed that fresh grasshoppers were rich in protein (56.43±2.84 g/100 g dry matter) and in most minerals. The mineral contents ranged between 0.65±0.11 g/100 g DM for Zinc and 2434.45±11.06 g/100 g DM for calcium. These values witnessed slight or important decrease upon frying. Fortunately, heavy metals were not detected in both samples. However, the fresh products appeared to be highly contaminated by such bacteria as *Escherichia coli*, Salmonella, total and fecal coliforms, sulfite reducing clostridia, lactic acid bacteria and yeasts. If some species were not detected in fried grasshoppers, the residual bacterial population remains worrisome. This study revealed that grasshoppers could be regarded as a cheap means of nutrients in general and proteins and minerals in particular. To benefit from all their nutrients safely, the insects must be properly processed to avoid any microbial contamination.

**Key words:** Grasshoppers, proteins, safety, food security, mineral contents, Cameroon

## INTRODUCTION

Food security is a crucial issue in most developing countries like Cameroon. The recent decades witnessed frequent outbreaks of famine in the Sahelian regions of the country. These regions are subjected to seasonal food shortages when cereals suddenly lack at a period of energy expenditure (Garine and Koppert, 1988; De Garine, 1993; Garine, 1993). The phenomenon is due to several reasons: low rainfall, invasion of plantations by elephants from neighboring natural reserves and by clouds of grasshoppers. The populations of the northern parts of Cameroon also face severe nutrients deficiencies targeting mostly women and children. It is estimated that 25% are affected by protein-energy malnutrition, 50.6% by vitamin deficiencies while 57.5% exhibit anemia (Helen Keller International, 2006). With regard to the above mentioned deficiencies especially protein-energy malnutrition, the continuous decrease of the local populations' purchasing power and the regular increase of meat and fish prices raise the question of alternative cheap and available sources of protein. In this respect, specialized agencies such as FAO attributed to insects in general and grasshoppers in particular a possible role in combating not only malnutrition but also poverty in general. In addition, recent studies showed that these insects, paradoxically associated with damages in cereal plantations could be excellent sources of proteins, sugars and vitamins (Bukkens, 2005). Moreover, Durst and Shono (2010) revealed that the protein yield (kg of feed $kg^{-1}$ meat produced) is 10-20 folds that of cows. This might have been understood by some people of Cameroon and Chad. In effect few ethics groups used to eat grasshoppers, generally captured in plantations in these regions as meat substitute. The insects are eaten fried in a sauce seasoned with a mixture of local condiments (pepper, parsley, celery, thyme, tomato and salt) and are considered by them as an income generating

**Corresponding Author:** Ahmed Ali, Department of Chemical Engineering, University Institute of Technology Ngaoundere, Cameroon

activity carried out in local markets. Limited to few groups at the beginning, the activity tends to spread across the whole region. Despite this increasing interest in insect consumption, little information is available to support the practice and provide valuable nutritional data to interested people. Hence, the present research was realized to determine the proximate composition of grasshoppers and to investigate their safety. To this effect, the major nutrients contents (proteins, fats, vitamins and minerals) were determined on one hand while heavy metals and pathogenic microorganisms were screened on the other hand.

## MATERIALS AND METHODS

**Area of study:** The area of study is part of the soudano-sahelian region of Cameroon from north of Maroua (10°30') to the Lake Chad (13°). It is characterized by low rainfall (<800 mm), alluvial soils, vegetation made up of shrubs and periodically flooded plains locally called yaeres. People mostly rely on the culture of millet and cattle rearing. The natural reserve of Waza with very important populations of elephants is situated in this region. As a consequence, these huge mammals frequently devastate culture and even kill people. Also insects regularly invade millet and sorghum cultures. Put together, environmental conditions and action of animals and insects created quite endemic food insecurity.

**Samples collection and preparation:** Samples of grasshoppers came from Ndjamena Farra (Chad) and Goulfei (Cameroon) and were bought in the market of Kousseri (Cameroon). The kg of fresh insects was sold at 2000 CFA francs (about 4 US$) while the fried ones were sold at 6000 CFA francs (about 12 US$). Samples were immediately kept in sterile bags and transported in hygienic conditions to the laboratory. The wings, posterior legs and antenna were first removed. Then 200 selected whole insects were divided into two groups of 100 individuals: the first was analyzed fresh while the second was treated according to the traditional process including immersion in boiling water for 30 min, sun-drying for 3-6 h and frying for 15-20 min in vegetable oil.

**Physico-chemical analysis:** The morphological characteristics were carried out on each of the two groups of 100 insects. The size and weight were measured using a ruler and a 0.001 precision balance (Precisa, France). After calibration, the two groups of samples (fresh and fried grasshoppers) underwent chemical analyses. The water and total ash contents were determined by normalized method. The total lipids were extracted in Soxhlet using hexane and were determined according to Bourely. The crude proteins were mineralized by the method of Kjeldhal and the nitrogen obtained was analyzed according to Devani *et al.* (1989). The crude protein content was obtained by multiplying the nitrogen content by the conventional factor of 6.25. The vitamin E content was evaluated according to the method described by Kivcak and Mert (2001) used to determine α-tocopherol. Minerals and heavy metals (P, Ca, Mg, Na, Ag, Mn, Fe, Zn, Cu, Cd, Cr, Pb) were determined by atomic absorption spectrometry (AAS 50B, Australia) after solubilization of ashes in hydrochloric acid.

**Microbiological analyses:** Fresh and fried insects were screened for total mesophilic flora, lactic acid bacteria, *Escherichia coli*, Salmonella, total and fecal coliforms, sulfite reducing clostridia and yeasts using specific culture media and plating conditions described by Mohamadou *et al.* (2009).

**Data analysis:** The values obtained from three repetitions for the physico-chemical analyses are expressed in means ±standard deviation. The number of microorganisms is expressed in $\log_{10}$ of Colony Forming Units (CFU). The results were analyzed using Microsoft Excel software.

## RESULTS AND DISCUSSION

Morphological characteristics and proximate composition of fresh and fried grasshoppers are shown in Table 1. Calibration revealed average size of 4.95±0.70 and 4.72±1.12 cm for fresh and fried insects, respectively while their average weights were 1.41±0.33 g (fresh grasshoppers) and 1.94±0.92 g (fried grasshoppers). The insects size was slightly reduced upon frying on one hand. This is probably due to water losses (7.23±0.41 for fresh grasshoppers to 2.99±0.05 for fried ones).

On the contrary, the increase in weight could be explained by oil absorption during the frying in vegetable oils which largely compensated the loss in water and other soluble substances. Interestingly, it appears that 1 kg of fresh products when fried gave 1.38 kg of edible food. In addition, the loss in water could enhance the product's availability and preservation time. With regard to chemical composition, the total ash content varied between 7.35±0.53 and 3.07±0.46% for fresh and fried samples, respectively. The decrease could be attributed to lessivation during the different treatments, namely washing in boiling water and frying. However, the final ash content remained interesting, thus traducing an important mineralization of the products. Significant

Table 1: Physico-chemical properties of fresh and fried grasshoppers

| | Grasshoppers | |
|---|---|---|
| Parameters | Fresh | Fried |
| Size (cm) | 4.950±0.700 | 4.720±1.120 |
| Weight (g) | 1.410±0.330 | 1.940±0.920 |
| Moisture content (%) | 7.230±0.410 | 2.990±0.050 |
| Total ash (%) | 7.350±0.530 | 3.070±0.460 |
| Proteins (g/100 g DM) | 56.430±2.840 | 52.580±2.350 |
| Fats | 8.040±0.210 | 42.130±2.760 |
| Vitamin E (mg/100 g) | 10.670±0.780 | 30.480±3.710 |
| Copper (mg/100 g DM) | 74.820±3.060 | 61.980±5.120 |
| Zinc (mg/100 g DM) | 0.650±0.110 | 0.710±0.080 |
| Sodium (mg/100 g DM) | 257.080±21.12 | 217.715±3.810 |
| Potassium (mg/100 g DM) | 272.280±10.34 | 169.650±8.430 |
| Magnesium (mg/100 g DM) | 965.210±10.77 | 719.840±6.090 |
| Calcium (mg/100g DM) | 2434.450±11.06 | 1841.960±7.440 |
| Manganese (mg/100 g DM) | 48.640±3.890 | 21.560±6.100 |
| Iron (mg/100 g DM) | 175.987±67.04 | 154.430±11.67 |
| Chrome | ND | ND |
| Cobalt | ND | ND |
| Nickel | ND | ND |
| Lead | ND | ND |
| Cadmium | ND | ND |

DM = Dry Matter; ND = Not Detected or below detection limit

protein contents were determined for both fresh and fried grasshoppers: 56.43±2.84 and 52.58±2.35 g/100 g DM. Hence, protein represented >50% of the total weight of the dry matter. Total fats of the fried insects were 5 folds that of fresh grasshoppers. This could be due to oil absorption in the frying operation. Protein and fat contents are comparable with those of caterpillars estimated at 63.5±9 and 15.7±6.3 g/100 g DM, respectively. However, these values are greater than those obtained for beef and fish meat by Ali *et al*. (2011).

In addition to their proteins and fats contents, the insects showed very promising mineral and vitamin E values. The vitamin E increased from 10.67±0.78 mg/100 g DM for fresh grasshoppers to 30.48±3.71 mg/100 g DM for the fried ones. This vitamin which is fat soluble could have been increased during frying and absorbed with vegetable oil. Minerals in ready to eat grasshoppers were: 61.98±5.12 mg/100 g DM (for Cu); 0.71±0.08 mg/100 g DM (for Zn); 217.715±3.81 mg/100 g DM (for Na); 169.65±8.43 mg/100 g DM (for K); 719.84±6.09 mg/100 g DM (for Mg); 21.56±6.1 mg/100 g DM (for Mn); 154.43±11.67 mg/100 g DM (for Fe) and 1841.96±7.44 mg/100 g DM (for Ca).

It is known that the mineral content of insects is dependent on their feed. Given that grasshoppers captured around Lake Chad are fed with plants cultivated with fertilizers, their mineral values probably reflect that of plants. They appear to be very rich in Ca, Na, K and Mg. These contents were reduced upon frying but could contribute to a significant extent to meet the required daily needs of consumers. Interestingly, no heavy metal was detected in both fresh and fried grasshoppers. This traduced the absence of heavy metals in plants from the region and to a certain extent, it could be assumed that soils are heavy metals-free. If the chemical hazards are very limited in both fresh and fried samples, it was not the case for microbiological contamination (Table 2). Analyses of fresh grasshoppers revealed that total mesophilic flora as well as fecal contamination indicators were detected at concentrations far above the recommended norms.

Table 2: Microbiological quality of fresh and fried grasshoppers

| | Grasshoppers | |
|---|---|---|
| Types of microorganisms (log10 (CFU $g^{-1}$)) | Fresh | Fried |
| Total aerobic mesophilic flora | 7.79 | 7.08 |
| Lactic acid bacteria | 5.28 | ND |
| *Escherichia coli* | 5.32 | 1.72 |
| Salmonella | 5.48 | 1.00 |
| Total coliforms | 7.13 | 2.84 |
| Fecal coliforms | 8.32 | 2.46 |
| Sulfite reducing clostridia | 5.48 | ND |
| Yeasts | 5.22 | ND |

ND = Not Detected or below detection limit

The presence of Salmonella raised the issue of the quality of water used. Consumed in this state, the risk of toxiinfections could not be neglected. Frying reduced most of these microorganisms. The absence of sulfite reducing Clostridia which are thermotolerant spore formers indicates that the heat treatment was sufficient to destroy the contaminants.

Hence, *E. coli*, total and fecal coliforms numbered in fried products could be indicatives of recontamination after processing. Generally, the hygienic conditions of food processing in some developing countries are often questionable.

Ali *et al.* (2011) have recently suggested training local populations in good processing practices to help limiting food borne pathogens.

## CONCLUSION

This study revealed that grasshoppers from Far North of Cameroon have appreciable nutritional quality. The insects studied exhibited very important contents in most nutrients with special emphasis on the protein content. Consequently, grasshoppers could be reasonably considered as alternative source of proteins to meat and fish to combat the endemic protein-energy malnutrition that prevails among women and children of the region on one hand and an income generating activity for poor rural populations on the other hand. The full valorization of these products must be accompanied by more regard on the hygienic practices to avoid microbial hazards.

## REFERENCES


Ali, A., D. Ahmadou, B.A. Mohamadou, C. Saidou and D. Tenin, 2011. Influence of traditional drying and smoke-drying on the quality of three fish species (*Tilapia nilotica, Silurus glanis* and *Arius parkii*) from Lagdo Lake, Cameroon. J. Anim. Vet. Adv., 10: 301-306.

Bukkens, S.G.F., 2005. Insects in the Human Diet: Nutritional Aspects. In: Ecological Implications of Minilivestock. Potential of Insects, Rodents, Frogs and Snails, Paoletti, M.G. (Ed.). Science Publishers, Enfield, pp: 545-575.

De Garine, I., 1993. Culture, Seasons and Stress in Two Traditional African Cultures. In: Seasonality and Human Ecology, Ulijaszek, S.J. and S.S. Strickland (Eds.). Cambridge University Press, Cambridge, New York, Melbourne, pp: 184-201.

Devani, M.B., S.A. Shishoo and B.N. Suhagia, 1989. Spectrophotometric method for the micro determination of nitrogen in kjedahl digest. J. Assoc. Official Anal. Chem., 72: 953-956.

Durst, P.B. and K. Shono, 2010. Edible Forest Insects: Exploring New Horizons and Traditional Practices. In: Edible Forest Insects: Humans Bite Back, Durst, P.B., D.V. Johnson, R.N. Leslie and K. Shono (Eds.). FAO, Geneva, pp: 1-4.

Garine, I. and G.J.A. Koppert, 1988. Coping with Seasonal Fluctuations in Food Supply Among Savanna Populations: The Massa and Mussey of Chad and Cameroon, In: Coping with Uncertainty in Food Supply, De Garine, I. and G.A. Harrison (Eds.). Clarendon Press, Oxford, pp: 210-260.

Garine, I., 1993. Contribution of Wild Food Resources to the Solution of Food Crises. In: Coping with Vulnerability and Criticality: Case Studies on Food-Insecure Groups and Regions, Bohle, H.G., T.E. Downing, J.O. Field and F.N. Ibrahim (Eds.). Breitenbach Verlag, Saarbrucken, Allemagne, pp: 339-359.

Helen Keller International, 2006. Selected results of the national survey on vitamin A deficiency and anaemia in Cameroon. Communication at the Seminar Addressing Micronutrient Deficiencies in Urban and Peri-Urban Populations in West and Central Africa through Musa-Based Foods, March 1-2, 2006, Limbe, Cameroon.

Kivcak B. and T. Mert, 2001. Quantitative determination of α-tocopherol in Arbutus unedo, by TLC-densiometry an colorimetry. Fitoterapia, 72: 656-661.

Mohamadou, B.A., C.M.F. Mbofung and D. Thouvenot, 2009. Microbiological and organoleptic profiles of mbuja: A traditional condiment produced by fermentation of *Hibiscus sabdariffa* seeds in cameroon. J. Food Technol., 7: 84-91.