International Scholars Journals

Advances in Food Science and Technology ISSN: 6732-4215 Vol. 5 (3), pp. 001-004, March, 2017. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Impact of drying technique and area on proximate substance composition of African metallic wood boring Beetle, Sternocera orissa (Coleoptera: Buprestidae)

***Elon C. Theron, Reeva Thabo Musk and Oscar Dave Tutu**

Department of Agro-Food Technology, Faculty of Agricultural and Environmental Sciences, University of South Africa, Pretoria, South Africa.

Accepted 15 October, 2016

Composition of proximate chemical composition in edible insects may depend on drying method and/or vegetation (location). Influence of drying method and location on proximate chemical composition of African metallic wood boring beetle (*Sternocera orissa),* widely consumed in certain rural communities of Limpopo Province, South Africa, was investigated. Randomised complete block design in a 3 × 3 factorial arrangement was used wi th three drying methods (oven-drying, freeze drying, locally method) and three locations (Khureng, Magatle, Ga-Masemola), with three replicates. Proximate chemical composition data were subjected to a two-way analysis of variance (ANOVA) and means were separated using Turkey Honestly Significant Differences (HSD) at 5% level of significance. Relative to freeze-drying, oven-drying and cooking methods increased protein, carbohydrates, fat, energy, ash and dry matter content with the exception of cooking method, which decreased the moisture content. Compared to other locations, Ga-Masemola significantly increased fat and energy of the test beetles. Results of the study suggested that oven-drying and cooking methods improved the proximate chemical composition of *S. orissa*, which has the potential of enhancing nutrition in marginal rural communities of Limpopo Province.

Key words: *Sternocera orissa*, protein, carbohydrate, fat, energy, ash, dry matter, moisture.

INTRODUCTION

One of the principal responsibilities of agro-processing is to preserve nutrients through all phases of food acquisition, processing, storage and preparation (Niir Board, 2001). Food preservation is the process of treating and handling food to stop or greatly slow down spoilage accelerated by micro-organisms. Most food preservation methods include pasteurisation and/or drying. Pasteurisation requires food to be sealed after treatment to prevent recontamination, whereas drying methods allow food to be stored for long periods without any special containment. Common drying methods include heat and freeze drying.

Freeze drying is a technique whereby continuously frozen specimen are dehydrated by sublimation and vacuum, without significant loss of physical form or colour (Harbach and Harrison, 1983). Due to the absence of liquid water and low temperature employed in this process, most microbiological reactions cease with the final product having excellent quality (Ratti, 2001). The method does not change product flavour, smells and nutritional content but guarantees long product shelf life (Adam, 2004). Although oven drying is the most commonly used, the challenge is that it may not enhance nutrient stability and bioavailability (Niir Board, 2001; Potter and Hotchkiss, 1995). African metallic wood-boring beetle *(Sternocera orissa*), widely known by the Pedi speaking people as Lebitsi-kgomo, is largely consumed by rural people in marginal

*Corresponding author. E-mail: theron.elon9@unisa.ac.za

communities of Limpopo Province, South Africa. The beetle is harvested from the beginning of December through mid-February. Development of this beetle from egg to adult requires several years (Chunram, 1974). Larvae are plant-tissue borers and may tunnel into leaves, twigs, branches, woody stems or barks. Eggs are laid in crevices of bark, whereas pupation occurs in the gallery (Chunram, 1974). Adult beetles are 3.5 to 4.0 cm long and weigh about 2.6 g (Quin, 1959). In most communities, the beetle is more preferred than Mopani worm (*Imbrasia belina*) because of its taste.

Preservation of *S. orissa* is a challenge among in most communities. Taste and quality of the beetle are said to deteriorate rapidly through micro-organism spoilage. The objective of the study was to determine the effects of drying method and location on proximate chemical composition of S*. orissa* in Limpopo Province of South Africa.

MATERIALS AND METHODS

Study location/area

Beetles were harvested around December 2009 from acacia trees (*Acacia campylacantha*) in three locations: Khureng (24°33'53''S, 29°23'4''E), Magatle (24°27'19''S, 29°23'39''E) and Ga-Masemola (24°33'46''S, 29°38'57''E) in Limpopo Province of S outh Africa. The three locations have the same climatic conditions (semi-arid), with rainfall as low as 400 mm per annum. Soil type in Khureng and Ga-Masemola are predominately clay, Magatle is sandy. Vegetation types in Khureng and Magatle are predominantly bushveld and Ga-Masemola are mixed bushveld.

Experimental design, treatments and procedures

Harvesting was done in the early morning when beetles were inactive on tree branches using the beating method (Holm, 1984), which dislodges beetles from branches. Beetles were picked from the ground, put in ventilated plastic bags and transported to the Limpopo Agro-Food Technology Station in cooler boxes and stored for three days in the refrigerator at -5°C prior to proce ssing (Finke et al., 1989).

Randomised complete block design in a 3 × 3 factoria l arrangement, where the three drying methods (freeze, heat and cooking) and three locations (Khureng, Magatle, Ga-Masemola) were replicated three times. In each treatment, 30 beetles with elytras and wings removed were used. Oven-drying treatment achieved at 66°C, ran for 24 h, whereas freeze drying at 085 mtorr (pressure) and -55°C for 24 h. Thirty beetles per treatment were cooked in 130 cm diameter frying pan with 50 ml tapwater until all free water had evaporated and then fried without adding cooking oil. Beetles from all treatments were individually ground using a coffee grinder and sealed in plastic bags using the impulse sealant (KS-300 Power 400 w, Source: 220 v 50 Hz, Hongzhan).

Proximate composition

Ash and moisture content were determined as described by Harris (1970). Organic matter was determined by heating samples at 550°C for 8 h. An Allihan Condenser Soxhlet extract ion apparatus was used to determine fat content with ether as an extractant, which was evaporated at 90°C and the fat left inside the beaker. Weight gained was used to calculate the fat content. Nitrogen was determined using the Kjeldahl method (Kjeltec, Tecator AB, Hoganas, Sweden) and the quantity of protein calculated as 6.25 x N (AOAC, 1984).

Data analysis

Analysis of variance was performed on treatments using Statistix 8.1 software (Statistix, Analytic Software, Statistix; Tallahassee, FL, USA, 1985-2003). Tukey Honestly Significant Differences (HSD) all – pairwise comparison test at 0.05 probability level was used to determine treatment differences among the means.

RESULTS AND DISCUSSION

Relative to freeze-drying, oven-drying increased protein, carbohydrates, fat, ash, dry matter and energy by 179, 151, 104, 177, 163 and 150%, respectively (Table 1). Oven drying increased the six variables more than hund-red fold, except for moisture content which decreased by 92%. Similarly, cooking increased protein, carbohydrates, fat, moisture, ash, dry matter and energy by 38, 30, 2, 22, 42, 32 and 27%, respectively (Table 1). Fat and energy content of *S. orissa* were significantly high at Ga-Masemola (Table 2).

Relative to freeze-drying the other two methods increased protein, which was in agreement with observa-tions on fish (Opstvedt et al., 2003), Atlantic spider (Margues et al., 2010). Increases in protein under drying temperature of 66°C may improve digestibility of pr oteins by unfolding polypeptide chains and rendering protein susceptible to digestive enzymes (Opstvedt et al., 2003; Potter and Hotchkiss, 1995). The protein content of *S. orissa* under all drying methods was higher than protein content of most conventional food (fish = 19.6%; eggs = 12.9%; milk = 4.0%; pork = 19.0%; beef = 18.4%; chicken = 22.0%; lamp = 16.1%) as reported by Ghaly (2009). Consequently, S*. orissa* adult beetles may be a cheap and abundant source of good quality animal protein for marginal communities in Limpopo Province.

Relative to freeze-drying, other methods tested increased carbohydrate, which agreed with findings of Raguse and Smith (1965), who reported that heat treatment caused a progressive increase in soluble sugars. Generally, most enzymes are not inactivated by freeze drying (Smith, 1969). However, simple sugars undergo changes when exposed to drying temperature and they react with other constituents (Goering and Van Soest, 1967; Van Soest, 1962). Hudson et al. (1941) and Thompson and Wolfrom (1958) demonstrated that complex carbohydrates degraded under the influence of temperature through cleavage of basic matrix structures with probable shift of bonds, resulting in formation of water soluble sugars.

Relative to freeze-drying and cooking, oven drying method increased fat content. Fat is essential in diets as

Table 1. Proximate chemical composition mean values of *Sternocera orissa* under three drying methods viz: freeze drying, traditionally cooking and oven drying method.

Proximate chemical composition	Drying method[y]			Relative to freeze method (%)[z]	
	Freeze	Cooking	Oven	Cooking	Oven
Ash	1.01[c]	1.44[b]	2.80[a]	42	177
CHO[b]	8.21[b]	10.69[b]	20.62[a]	30	151
DM[c]	36.55[b]	48.25[b]	96.26[a]	32	163
Energy	700.7[b]	894.3[b]	1785.3[a]	27	150
Fat	4.81[b]	4.92[b]	9.83[a]	2	104
Moisture	51.75[a]	63.45[a]	3.74[b]	22	− 92
Protein	22.51[b]	31.19[b]	63.00[a]	38	179

[y]Row means followed by the same letter were not different according to Tukey Honest Significant Difference Test at the probability level of 5%. Impactz = (treatment/freeze drying – 1)× 100, C HO[b] = carbohydrate, DM[c] = dry matter.

Table 2. Influence of three locations on proximate chemical composition of *S. orissa*.

Proximate chemical composition	Locations[y]			P ≤
	Khureng	Magatle	Ga-Masemola	
Ash	1.82	1.76	1.66	ns
CHO[b]	12.83	14.01	12.66	ns
DM[c]	57.93	58.74	64.38	ns
Energy	1028.3[b]	1071.0[b]	1281.0[a]	**
Fat	3.72[b]	5.12[b]	10.72[a]	**
Moisture	42.06	41.25	35.61	ns
Protein	39.54	37.83	39.33	ns

[y]Row means followed by the same letter were not different according to Tukey Honest Significant Difference Test at the probability level of 5%. ns = not significant at 10%, ** = significant at 5% level of probability, CHO[b]= carbohydrate, DM[c]= dry matter.

they increase the palatability of foods by absorbing and retaining their flavour (Aiyesanmi and Oguntokun, 1996) and it is also the main form in which energy is stored in insect larvae (Chapman, 1980; Gilmour, 1961; Wigglesworth, 1976). According to Martin et al. (1981), fats are vital in the structuring and biological functioning of cells and they help in transportation of nutritional essential fat-soluble vitamins.

Relative to freeze-drying, oven drying methods decreased the moisture content of *S. orissa,* which was in agreement with other findings in *Vernonia amygdalina*, fermented cassava product and tomato (Aliero and Abdullahi, 2009; Faramade and Faramade, 2005; Kolawole et al., 2010). Morris et al. (2004) demonstrated that moisture removal by heat improved food digestibility, increased concentration of nutrients and made some nutrient more available. In cooking method, moisture content was relatively high which could increase chances of deterioration by micro-organisms (Hassan et al., 2007). Generally, the ash content of a sample is the reflection of the level of minerals in then test sample contained (Omotoso and Adedire, 2007). Since cooking and oven-drying increased the ash content, the two treatments probably increased the level of nutrients elements.

Conclusion

The relatively high proximate chemical composition of S. *orissa* when prepared using readily available technolo-gies such as drying and cooking, renders this beetle a probable candidate for use in amelioration of malnutrition in marginal communities of Limpopo Province. However, there is need to determine proximate chemical composi-tion of *S. orissa* under varying times and temperature regimes in order to establish the level where the tested variables could be optimized.

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