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Potential Value of Acridids as High Protein Supplement for Poultry Feed

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Abstract: It is well known that acridids are an attractive and important natural source of food for many kinds of vertebrate animals, including birds, lizards, snakes, amphibians, fish and other mammals. Despite that they drew very few research attentions as feed for domesticated animals, particularly poultry, swine and freshwater fish. In the present study energy estimation and proximate analysis were conducted for four acridid species in order to determine the nutritional quality of those species and their potential value as an alternative animal protein source. The experiment revealed acridids to have a higher amount of protein content in compared to the conventional soybean and fish meals. A high amount of caloric contents were also evident in the chosen acridids. The most important conclusion of this study was that the acridids can provide a reliable and sustainable source of high quality animal protein for domesticated animals.

Key words: Nutritional potential, acridids, animal feed

Introduction

Insects in nature constitute a significant biomass, as is exemplified by the insect pests. These are mostly primary consumer and due to their high rate of reproduction tend to dominate all the sources of energy because of competitive exclusion (Ramos - Elorduy, 1997). The many benefits that insects offer us are often overlooked and underestimated. For instance, they can be used in human and animal nutrition, in medicine and also as recycles of organic matter. Most insect species convert plant protein to insect protein very efficiently (Taylor, 1979) resulting in a high yield as compared with other breeding animals. The body tissue of edible insects may be 44-70% protein while their plant foods are only 9-10% protein (Ramos - Elorduy, 1987). According to Ueckert *et al.* (1972) insects are known to have high nutritional value and may be important source of protein, carbohydrate, fat, vitamin, minerals, etc. Dufour (1987) opined that protein content of ant, termites and caterpillars are higher than dried fish. Finke *et al.* (1985) incorporated Mormon cricket replacing Soybean meal as major source of protein in practical chick diet and found no significant difference in chick weight gain. Notably Acridids which comprises locusts and grasshoppers represent tones of edible insect protein wasted. The protein content of grasshopper varied from 52.1 to 77.1% and the quality of this protein is good and rich in several amino acids than the Food and Agricultural Organization standards (Ramos- Elorduy *et al.,* 1982; Ramos - Elorduy, 1984). In Argelia Locusts and *Schistocerca* produce 9 tons of biomass per year (Gunn, 1960) and Mexico *Sphenarium* sp. produces more than 10 tons of biomass per year (Ramos - Elorduy, 1997). Enormous amount of toxic chemicals is used in these countries to kill them. However, insect pests are eaten by several ethnic groups (Ramos-Elorduy and Pino, 1993) and many species are preserved and stored for consumption as is the case with locusts and caterpillars of different species in Africa and with the *Sphenarium* grasshopper and many bugs in Mexico. In South Africa, Ledger (1987) suggested harvest of brown Locust, *Locustana pardalina* (Walker) as human and animal food to reduce the use of insecticides on this pest. Studies on the biology, ecology and behavior of Acridids reflect their high reproductive potential (Lomer *et al.,* 2001) and rapid life cycle (Ananthakrishnan *et al.,* 1985). Because of their high nutritional value and ubiquitous presence; acridids present a potential sustainable food resource in animal nutrition. A variety of insects have been shown equivalent or superior to soybean meal as a high protein source for chick growth (De Foliart *et al.,* 1982, Finke *et al.,* 1985; Nakagaki *et al.,* 1987). Teotia and Miller (1974) observed no significant difference in weight gain, food consumption, or food conversion between chicks fed house fly pupae and chicks fed a fully balanced diet. (Teotia and Miller, 1973) reported no adverse effect on carcass quality and taste of the birds fed pupal diet. Studies on nutritional potential of acridids indicate that acridid tissue comprises more good quality protein than the commercially used animal protein sources in poultry feed. DeFoliart (1989) suggested development of controlled mass production of food insects indigenous to developing countries. According to DeFoliart (1992) if insects become more widely accepted as food in the industrial countries, the economic implications are obvious. Thus once suitable species are selected and appropriate breeding methods are developed, insects can provide a reliable and sustainable source of high quality animal protein.

With the view of utilizing acridids as nonconventional protein supplement in animal feed an attempt has been

Table 1: Nutritional evaluation of four acridid species

Specimen	Crude protein % ±SE	Crude fibre % ±SE	Crude lipid % ±SE	Carbohydrate % ±SE	Ash % ±SE	Energy (Kcal/g) ±SE
O. fuscovittata	63.96±0.05	7.51±0.16	6.49±0.03	7.51±0.32	5.01± 0.03	4.65±0.04
A.exaltata	64.46±0.08	7.73±0.09	7.07±0.01	3.64±0.19	4.98± 0.01	4.95±0.01
S.pr.prasiniferum	65.88±0.04	6.96±0.16	8.11±0.01	6.36±0.13	5.11± 0.04	5.50±0.04
H. banian	63.61±0.10	7.16±0.13	7.15±0.02	4.81±0.24	4.86± 0.04	5.66±0.02

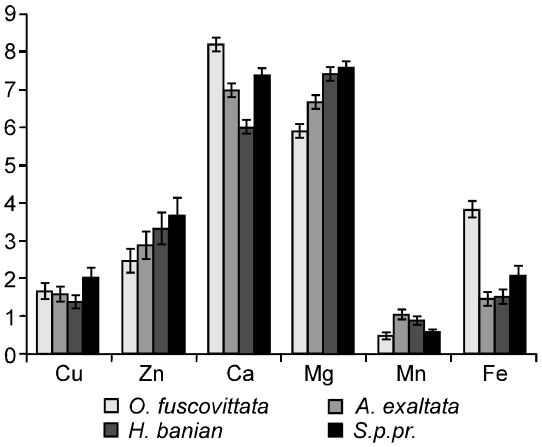

Fig. 1: Mineral content (in ppm) in four acridid species.

made for nutritional evaluation of four species of acridids viz. *Oxya fuscovittata* Marschall, *Acrida exaltata* Walker, *Hieroglyphus banian* Fabricius and *Spathosternum prasiniferum prasiniferum* Walker which were well abandoned in the study area around Santiniketan. This knowledge is of immense importance as mass rearing of these nutritive acridid species following Haldar *et al.* (1998) method may lead to establishment of acridid farms in near future, which may serve to sustain poultry industries by supplying economic and self sustainable protein supplement in poultry diet. Moreover harvesting these food acridids from cropland and grasslands may lead to lesser utilization of harmful pesticides for their control and protect the environment from their hazardous effects. Thus these harmful insects may be utilized in a useful way as economic and self sustaining protein supplement in poultry diet especially in the developing countries like India.

Materials and Methods

Sampling: Acridids of interest i.e. *O. fuscovittata, A. exaltata, H. banian* and *Sp.pr. prasiniferum* were collected from nearby agricultural and grassland fields of Santiniketan (23°39'N, 87°42'E) Birbhum, West Bengal, India, by sweeping technique and reared under laboratory conditions i.e.30-35°C temperature, 70-90% relative humidity and @12D/12N photoperiod following the Haldar *et al.* (1998) method.

Chemical analysis: Acridids were freeze killed then dried in hot air oven at 40°C. Crude protein was determined by Kjeldahl method using Micro Kjeltech Apparatus.

Carbohydrate contents of four Acridid species were estimated following Anthrone method. The fresh Acridid tissue was homogenized with 0.1M phosphate buffer (pH- 7) and centrifuged at 7000 rpm for 15 minutes. The supernatant was then analysed for carbohydrate content following Umbrit *et al.* method.

Crude lipid content was determined using Soxhlet apparatus 2.0 gm of sample was wrapped with a Whatman filter paper (No. 1) and placed in a thimble connected with Soxhlet apparatus. The initial weight of the Soxhlet flask was recorded and filled up with 200 ml Petroleum ether (boiling point 60 - 80°C). The total apparatus was then placed over a mantle and the petroleum ether was allowed to boil for 6 - 8 hr and circulate through the thimble by Siphon process. After boiling, the flask was taken out and the Petroleum ether was allowed to evaporate. The crude lipid was determined by the difference between final weight and initial weight of the flask.

Caloric content of the Acridids was determined by Oxygen Bomb Calorimeter (Instrumentation India Co.). 1gm of dried powdered sample were transformed into pellets by a pelletizer, charged with O_2 at 300 kg/ cm^2 of pressure within the bomb and analyzed for energy content by recording the temperature rise in °C as obtained by firing the charged bomb with sample in the Digital Oxygen Bomb Calorimeter (Instrumentation India Co.).

To determine the mineral content such as calcium, iron, zinc, magnesium, manganese in the tissue acridids, the specimen were freeze killed and dried in a hot air oven at 50°C for 48 hours. The dried samples were finely ground to powder and wet digested in aqua regia at 140°C for 3 hr. After cooling, the clear samples were diluted and metal concentration was determined by Atomic absorption Spectrophotometry (Varian Tectron AA575 series).

Analysis of data: Data are presented as means ±SE. One way analysis of variance (ANOVA) were carried out to compare the values between different acridid species using Microsoft excel 2000 software.

Results and Discussion

The results as tabulated in the Table 1, indicated that the protein content in acridids ranged from 60% to 66% of dry weight and the species wise variation in protein content was in between 1-6%. The maximum amount of protein was found in *S. pr. prasiniferum* (65.88% crude

protein), which is a grassland species. The percentage of crude lipid ranged more or less in between 5%- 8% in all the species.

The carbohydrate content of the chosen grasshopper species was found to be in between 3.6-7.5% where *O. fuscovittata* showed the highest and *A. exaltata* showed the lowest amount.

A high amount of Ca, Mg, Zn, Fe, Cu but relatively low amount of Mn was found in the acridids of interest (Fig. 1) and this was found to be enough to meet the daily requirements of major trace elements of poultry birds.

The energy content in the chosen acridids ranged from 4.5 to 5.6 Kcal per gm of dry tissue. Maximum amount of energy content was observed in *S. pr. prasiniferum.*

Results of the present study indicate that the insects can potentially substitute for commercial products as a source of protein in animal diets. There were no significant differences in weight gain, food consumption, food conversion, carcass quality or palatability of birds when *Tenebrio molitor L.* were substituted for soybean meal in the diets for young chickens (Ramous-Elorduy *et al.,* 2002). Similar finding had been reported when feeding poultry *Anabrus simplex* Haldeman (DeFoliart 1989, Finke *et al.,* 1985), *Acheta domestica* L. (DeFoliart, 1987, Nakagaki and Defoliart, 1991), *Bombyx mori* L. (Fagonee, 1983, Joshi *et al.,* 1980), *Apis mellifera* L. (Turkey and Szaboti, 1981), *Alphitobius diaperinus* Panzer (Despins, 1994), *Tribolium castanium* Herst. (Vhora *et al.,* 1983) and termites (Sanaiya, 1995).

Insects have also been used as a food source for rainbow trout (Ramous-Elorduy *et al.,* 1984). These studies supported the nutritional quality of insects as a protein source without adverse effects on the vertebrates.

From the present study it can be concluded that Acridids are superior to the conventional protein supplements such as soybean meal (48% crude protein) and fish meal (50-55% crude protein) by having a high protein content (60-66%) and a good amount of calorie (4.5to7 kcal/gm), total fat (6-7.5%), total carbohydrate (3.6-7.5%) and mineral contents. On the other hand acridids have a similar protein and energy content when compared with the other insects such as *T. molitor* (60.2% and 5.54 Kcal/gm respectively) (Ramous-Eloduy *et al.,* 1992). Moreover advantages of use of acridids as a diet include the minimal physical space and potential for massive production (Haldar *et al.,* 1998).

These results highly support the idea of establishment of Acridid farms and utilization of these harmful insects in a useful way in poultry feed. This may provide job opportunity for the rural unemployed. Moreover, harvesting food acridids from croplands will minimize the use of pesticides for management of pest acridids and reduce the environmental pollution.

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