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NUTRITIVE VALUE OF NORMAL AND OPAQUE-2 MAIZE

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ABSTRACT

In an isonitrogenous feeding experiment with albino rats the biological value of a high lysine opaque-2 composite 'Shakti' and three normal maize varieties, namely, composite 'Vijay', 'Ganga-5' and Basi was tested. The biological value of opaque-2 maize was 90% of milk protein casein while that of normal maize varieties was less than 70% of casein. Opaqae-2 maize also had significantly higher percentage of net protein utilization and utilizable nitrogtn compared to normal maize varieties. When opaque-2 maize was fed at inherent protein level with mineral and vitamin supplementation, the weight gain in rats was 54·4 g on opaque-2 diet and 43·3 g on Balahar in a 28-day feeding trial. Feed efficiency ratios were respectively 4·01 and 4·24 for opaque-2 maize diet and Balahar.

INTRODUCTION

THE discovery opaque-2 gene resu'ts in marked increase in lysine and tryptophan contents[1], has opened up new vistas in improving protein qua'ity. Following the work on maize, mutants with high lysine contents have also been identified in barley[2] and sorghum[3]. Most of the biochemical studies, conducted so far[4-6] have clearly established that opaque-2 maize endosperm protein contains 15–27% zein as compared to 54–59% in normal maize. Since zein is extremely deficient in lysine and tryptophan and rich in leucine, the net result is improved amino acid composition in opaque-2 maize. Besides this, normal maize protein has higher leucine-isoleucine ratio which is responsible for the development of pellegra in populations subsisting mainly on maize[7]. In the present study evaluation of protein quality of one opaque-2 composite, one normal hybrid, one normal composite and one open pollinated local maize varietv has been done by nitrogen-balance study.

MATERIALS AND METHODS

Three normal maize varieties, namely, Vijay, Ganga-5 (a hybrid) and Basi (a local) and an opaque-2 composite Shakti were tested. The baby foods 'Amulspray' (milk based), and 'Balamul' (cereal and milk based), Balahar (atta, 85% and edible groundnut flour, 15% fortified with vitamins and minerals) and casein were used in this investigation.

Crude protein content (N × 6·25) was determined by micro-Kjeldahl method[8], and lysine was estimated by amino acid analyser.

Nitrogen Balance.—The N-balance of each sample was determined in five Wistar male growing rats by the Mitchell and Carman method[9]. Rats were arranged in groups of five with an average weight of 100 g. The total experimental period of nine days consisted of four days preliminary feeding followed by a five day balance period in which pooled faeces and pooled urine were analysed for nitrogen. Each rat received a constant amount of 10 g dry matter and 150 mg nitrogen daily. Water was given *ad libitum*. All grain diets and casein supplemented with 1% methionine were fed as isonitrogenous diets at 9·5% protein. Nitrogen content of each diet was adjusted using N-free diet mixture[10]. The experimental diet contained 4% mineral and 1% vitamin mixture[10]. Metabolic-N and endogenous-N were determined as described by Eggum[10].

Feed Efficiency Ratio (FER).—The FER (g of feed consumed per g of body weight gain) of Shakti, Amulspray, Balamul and Balahar at their inherent protein levels was also determined. Only opaque-2 diet was supplemented with 4% mineral and 1% vitamin mixture as other foods were already supplemented with minerals and vitamins. Wistar male growing rats having initial average weight of 41·5 g were used. Rats were arranged in groups of five. Experimental diets were fed to each rat for 28 days. Rats were given diet and water *ad libitum*. Individual weight gains and feed consumption were measured after 7, 14, 21 and 28 days. FER was calculated for each rat.

RESULTS AND DISCUSSION

Results of analysis of maize samples are given in Table I. The local maize variety Basi had the highest protein with lowest lysine content, this led to very low chemical score. The protein content of opaque-2 maize was comparable with Vijay and Ganga-5 but it had substantially higher (about 44%) lysine content. The chemical score for Shakti was highest being 40–56% greater than the normal maize varieties.

TABLE I

Chemical score of normal and opaque-2 maize varieties

Maize variety	Protein (%)	Lysine (g/16 g N)	Chemical score* (%)
Vijay	11·00	2·70	49·1
Ganga-5	11·81	2·84	51·6
Basi	13·19	2·56	46·5
Shakti (opaque-2)	11·69	3·98	72·4

* Based on lysine as the first limiting amino acid and 5·5 glysine/16 g N in 1973 reference amino acid pattern.

that opaque-2 maize had a PER value to be 62%–110% superior to that of ordinary maize.

Feed Efficiency Ratio.—Since the experimental data at hand clearly indicated nutritional superiority of opaque-2 maize the FER of opaque-2 maize was compared with two of the popularly used baby foods, Amulspray and Balamul and a pre-school children supplementary food Balahar. These materials were fed to rats at their inherent protein levels with a view to determining the suitability of opaque-2 maize as a supplementary food for infants and pre-school children. Protein contents of the diets, the total weight gain by rats and FER values are presented in Table III. Opaque-2 maize used in the study contained 11·8% protein.

TABLE II

Mean true digestibility, biological value and other properties of proteins of maize varieties

Protein value expressed as a percentage	Casein	Maize varieties			
		Vijay	Ganga-5	Basi	Shakti
True digestibility	100·2±0·5	92·1±0·6	93·8±0 9	93·7±0·9	95·2±0·7
Biological value	84·1±4·4	56·4±2·9	59·9±0·8	56·0±0·9	76·0±1·3
Net protein utilization	84·2	52·2	55·6	52·6	72·3
Utilizable nitrogen	11·42	0·92	1·05	1·11	1·35
N in % of dry matter	13·57	1·76	1·89	2·11	1·87

Nitrogen Balance.—The results of N-balance study are presented in Table II. The casein supplemented with 1% methionine was used as a check. It is evident that the true digestibility (TD) of all the maize varieties under test was more than 90%. The biological value (BV) of the normal maize varieties ranged from 56–60%. The BV of opaque-2 maize was about 35% higher when compared to Basi and Vijay and 27% better than Ganga-5. The net protein utilization (NPU), a derived factor (TD × BV/100) which indicates actual retention by body, was substantially higher for Shakti opaque-2. However, the BV and NPU of opaque-2 maize were found to be 90% and 86% respectively of casein. The utilizable nitrogen (UN = NPU × nitrogen %/100), was found to be the highest for opaque-2 maize.

Among normal maize varieties, Basi had higher UN value (1·11) compared to Ganga-5 (1·05) and Vijay (1·92). Bressani[11] in his studies in Guatemala with 2–6 year old children found the protein efficiency of opaque-2 maize to be 90% of that of skim milk. Similarly Merts[12] in his tests with rats observed

TABLE III

Mean feed efficiency ratio (FER) of opaque-2 maize diet, Amulspray Balamul and Balahar in a 28 day rat feeding experiment

Diet source	Protein in % of dry matter (diet)	Average weight gain (g)	FFR
Shakti* (opaque-2)	11·18	54·4±4·8	4·01±0·21
Amulspray	24·08	88·5±7·7	2·14±0·05
Balamul	23·46	96·2±8·3	2·38±0·17
Balahar	25·69	43·3±4·6	4·24±0·16

* Opaque–2 maize was fortified with 1% vitamin and 4% mineral mixture.

It is seen that the FER value for opaque-2 maize diet is of the same order as Balahar. This indicates that opaque-2 maize, after supplementation with minerals and vitamins, could be a suitable material

for pre-school children. The FER values for Balamul and Amulspray were found to be 60% lower than for opaque-2 diet. The total weight gain with Balamul and Amulspray was much higher compared to Balahar and opaque-2 maize diet. Such results are not entirely unexpected since the total protein content of Amulspray as well as of Balamul is considerably much higher than in opaque-2 maize. Moreover, the protein of the baby food is of animal origin. In terms of economic and the possibility of rapid production of opaque-2 maize, the latter hold considerable promise.

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PROBLEMS ON HOST SPECIFICITY IN INSECTS

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A THREE-DAY symposium was convened by Dr. T. N. Ananthakrishnan, Director, Entomology Research Unit, Loyola College, Madras, from 24th–26th, January 1976, wherein participants from varied disciplines such as Agricultural Entomology, Botany, Zoology, Medical and Veterinary parasitology presented papers.

In introducing the subject, Dr. T. N. Ananthakrishnan stressed the need for an understanding not only of the host range spectrum of pest species, but also their fecundity, comparative growth rate and population dynamics on the varied hosts in order to correctly assess their role as pests. Among several instances he cited from his own work on thrips, he mentioned about *Haplothrips ganglbaueri* known in recent years to seriously infest paddy inflorescence in many areas and how a direct correlation existed between the infestation of this species in the weed *Echinochloa crusgalli* and *Oryza sativa.*

In his key note address on 'Insect nutrition and host plant selection,' Dr. N. C. Pant. Head of the Division of Entomology, I.A.R.I., New Delhi, emphasised the need for basic research and exhorted research workers to investigate aspects of nutrition of the insects of crop plants in depth, to elucidate the factors in the host plants that influence their choice of the pests.

In the three days sessions, about 32 papers were presented and three special lectures delivered. The technical papers covered a wide range of insect and acarine pests and parasites of importance in agriculture, medical, veterinary Entomology and included a discussion of the stimuli in the host plants or animals available to the insects for host selection and the response in them to exercise the specific choice. The groups so dealt with were the aphids, aleyrodids, tingids, membracids, pyrrhocorids, thrips, acridids, midges, anthomyids and mites of cotton, sorghum, millets, rice and other economic plants ; and mosquitoes, fleas, cimicids, mallophagans, ticks and mites ectoparasitic on man, birds and other animals. While the contributions discussed host preferences such as monophagy, oligophagy and polyphagy in terms of morphological, physical, chemical and biochemical factors in the plants or animals as determinants of such