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PROTEIN DIGESTIBILITY AND SENSORY EVALUATION OF SPAGHETTI FORTIFIED WITH VEGETABLE PROTEIN SOURCES

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ABSTRACT

Protein enhancement of spaghetti products was carried out through fortification with vegetable sources that cluded melon, groundnut and soyabean. The domino effects were evaluated using an animal model: nutritional, biochemical and sensory parameters of the new products were examined. Results showed that of the three fortificants, only soyabean gave a percent mean weight gain (86.70 ± 4.149) above that of control 5.54 ± 2.409). The mean protein efficiency ratio (PER) obtained for soyabean (1.75 ± 0.00) was statistically fferent (P< 0.05) from control (1.04 ± 0.00). Feeding spaghetti alone gave the poorest percent weight gain of (19.8 ± 1.64) and a mean PER of (0.51 ± 0.01) that was below that of the control. Serum protein content, a sensitive indicator of protein nutritional status was consistent with these findings. Panelists preferred aghetti fortified with soybeans over that fortified with groundnut and melon. In most cases, the mouth feel spaghetti fortified with soybean decreased with storage. However, general acceptability of the product was not affected. On the basis of nutritional and biochemical data, spaghetti fortified with soyabean is preferred.

eywords: Protein fortification, pasta products.

INTRODUCTION

A major problem in the Third World countries is the high incidence of protein energy malnutrition (PEM). This encompasses a range of disorders of starvation and malnutrition iat involve deficiencies of other nutrients such as vitamins and minerals in addition to protein (de Onis M 1995). The problem is particularly acute in developing countries where the diet is low in both animal and plant protein and dietary staples tend to be cereals and vegetable products (Agyepong and Valle 1995). Factors inhibiting the ioavailability of native protein in a diet high in vegetable content contribute significantly to the high incidence of protein-energy-malnutrition (PEM) in these countries (Protein Advisory Group 1971). One of the food-based strategies for preventing macro and nicronutrient malnutrition is the addition of nutrients to commonly eaten foods to maintain or improve the quality of the food item (WHO 1983). Two possible procedures are supplementation and fortification. The fortification of an inexpensive and easy-to-cook food such as spaghetti is a practical intervention strategy that could provide the most reliable method for achieving long-term enhancement of protein status especially in infants (Brees *et al.* 1997) and may therefore be recommended as an intervention

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strategy. In recent times, pasta products have received considerable attention as infants' food delight in view of its ease of preparation coupled with affordability.

Legumes have received greater attention as a rich source of protein and calories (Deshpande and Nielsen, 1987; Chen *et al.* 1995). At the same time, much research has focused on ways to increase their utilization in human nutrition (Bradbear and Boulter 1984). Adding legumes to commonly consumed and an easy-to-cook food such as pasta products (spaghetti) is one of the most economical methods. Because the amino acid compositions of legumes and cereals are complimentary, fortification of cereal products (including pasta) with legume protein increases the nutritional value (Nielson *et al.* 1980).

Lorenz *et al.* (1999) indicated that the addition of certain levels of protein concentrate to pasta products gives acceptable results in terms of nutrients availability and sensory evaluation. In the third world countries, food nutrient concentrate are not available, but rich vegetable sources that are affordable most especially for infants and pregnant women abound. Consequently, the objectives of this study were to:

- Establish the effectiveness of fortified extruded food noodles (spaghetti) in meeting the protein requirements of vulnerable groups especially children; and,
- Evaluate which of the three vegetable fortificants employed in this study gives the best protein availability when consumed.

Materials And Methods

The spaghetti used in this study was obtained from a supermarket. Soyabean, melon seed and groundnut used were similarly purchased, processed into fine powder to pass through a 200-mesh sieve. Milled spaghetti and fortificants were homogenously mixed together in appropriate ratio, extruded using an improvised locally fabricated extruder from the IITA Ibadan, packaged in plastic bags, and stored at room temperature (approximately 23^{0}C). These were used for animal bioassay and other analytical studies. Cerelac infant milk formula made by Nestle Plc, Nigeria was used as control against which all formulated diets were compared.

Thirty (30) male wistar albino rats from the same stock were obtained from an animal colony maintained in the Department of Animal Production and Health of Ladoke Akintola University, Ogbomoso. Animals were weighed, randomly distributed into metabolic cages and were adapted to the environment with a diet containing 4% casein for a period of seven days. After this period, animals were reweighed and regrouped such that average weight per group was approximately the same. Animals were kept on a 12-hour light and dark cycle with access to diet and water to drink *ad libitum*.

Animals from each group were placed on the experimental diets (including control) for a period of 35 days. During this period, water was also supplied *ad libitum* while food intake and growth changes were recorded. At the end of the feeding period, animals were killed by decapitation following chloroform anesthesia. Blood was collected for the following serum analysis: Na^+, K^+, Ca^{2+}, cholesterol, PO_4^{2-}, and serum protein (AOAC 1998). All analyses were made in triplicate and mean ± SD determined.

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Samples of spaghetti fortified with protein sources were presented for sensory evaluation in the form of cooked extruded products to panelists. Evaluations were made twice on the same day. Panelists, using a hedonic scale of 1 to 7 (with 7 being excellent and 1 being very poor) scored the samples.

The colour of spaghetti fortified with protein was measured with a Hunterlab Colour difference meter (Model D 25M-9, Hunter Associates Laboratory, Inc. Reston, USA) as described by Walsh *et al.* (1969).

Statistical analysis

Statistical analysis of the data was accomplished through the use of statistical software (Snedecor and Cochran 1967). The analysis of variance was performed to detect variation. Differences among mean values were identified by the Least Square Means methods (Steel and Torrie 1980).

RESULTS AND DISCUSSIONS

Mean weight gain and protein efficiency ratio (PER) were more than 300% greater in rats fed the spaghetti fortified with soybeans (Table 1) than in the spaghetti alone. The values obtained for these parameters were higher than corresponding values obtained for Cerelac control, indicating perhaps better energy content for these than in the control. The mean weight gain observed for both the groundnut and melon fortified samples was not significantly different ($p<0.05$) from the control. These values were observed to be higher than the unfortified spaghetti. The feed intake reflected the same trend as the mean weight gain. The protein intake, however, reflected the superior protein content of the rations. This value was also least for the unfortified spaghetti. The improved result observed with soybean is expected in view of the fact that trypsin inhibitor activities are normally destroyed at elevated temperatures. This observation is consistent with the high PER observed and is similar to views previously held (Chen *et al.* 1995).

The melon and groundnut fortified varieties though lower (296% and 282% respectively) were equally high, even higher than Cerelac (control). The poor feed intake observed with diet B must have resulted from lack of palatability of the diet. This poor feed intake was responsible for both the poor protein intake and PER observed. Lorenz *et al.* (1999) obtained similar poor protein intake with *faba* beans.

The serum protein obtained from animals on the test diets (Table 2) however differed significantly ($p<0.05$) from the animals on unfortified diet (B). Values observed for the groundnut and soybean fortified samples were not different ($p<0.05$) but were in agreement with control. Other serum biochemical values determined were consistent with similar works (Oke *et al.* 1996; Nielson *et al.* 1980).

The use of an animal model to predict human responses to dietary fortification had earlier been investigated by Buchowski *et al.* (1989) who established evidence that humans and rats absorb similar percentages of the biochemical parameters when protein statuses are identical (Zhang *et al.* 1989). Consequently the outcome of this work would be basis for a reasonable assessment of human responses in similar situations.

A comparison of means for all data on sensory evaluation is shown in Table 3.

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Panel members gave the best scores for the control sample for all parameters evaluated in the shelf life study. For the fortificants, spaghetti fortified with soyabeans was generally preferred for all the parameters evaluated. Though panelists returned the highest scores for this product, there was no significant difference ($p \leq 0.05$) observed between this and other fortificants. Colour and external appearance of the fortified products changed with storage time. This change was most pronounced in the melon-fortified sample at 12 weeks of storage for all the parameters considered. Mouth feel and general acceptability did not change appreciably with storage for both the groundnut and soyabean fortified varieties. These findings were consistent with the findings of Nielson *et al.* (1980). On the basis of total score, the soyabean-fortified variety was rated best.

Conclusion

The outcome of this study has indicated that the consumption of the spaghetti alone would not meet the nutritional needs of the animals. When this result is extrapolated to humans, one could infer that the protein requirement would be far from being met. However, upon fortification, there was improvement in the nutritional content. It is recommended that the extruded product (as presently sold in the market) be consumed with a vegetable protein sauce for an enhancement of the protein intake. Of the three vegetable protein types evaluated the decreasing order of preference identified was soyabeans, groundnut and melon. However, in view of local preference for melon soups, the market acceptance of melon could not be ignored and is therefore recommended as supplement.

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Table 1:Nutritional data on test animals fed different diets

Diets	*Animal*	*Initial weight*	*Final weight*	*Weight gain*	*% Weight gain*	*Mean Weight*	*Feed Intake*	*Protein Intake (24% of feed intake)*	*Mean PER*	*% Increase in PER*
Cerelac Control	A	24.09 ± 3.17	98.63 ± 2.4	75.54 ± 1.93	75.64 ± 2.61	75.54 ± 2.4	302.68 ± 21.86	72.64 ± 5.24	1.04 ± 0.01	204
SP + VP	B	22.27 ± 0.03	42.10 ± 1,56	19.80 ± 1.57	46.75 ± 1.46	19.80 ± 1.64	161.33 ± 5.55	38.74 ± 1.30	0.51 ± 0.06	
SP + VP + M	C	25.03 ± 1.47	98.87 ± 1.53	73.83 ± 1.98	74.68 ± 1.34	73.83 ± 2.6	203.86 ± 5.62	48.93 ± 1.35	1.51 ± 0.02	296
SP + VP + GN	D	27.03 ± 1.67	98.25 ± 4.00	69.55 ± 5.43	72.50 ± 0.77	71.27 ± 4.36	206.65 ± 11.24	49.60 ± 2.69	1.44 ± 0.12	282
SP + VP + S	E	21.70 ± 0.70	109.40 ± 4.58	86.70 ± 2.49	79.29 ± 1.36	86.7 ± 4.14	206.93 ± 5.88	52.99 ± 4.41	1.75 ± 0.03	342

Means are average of 4 determinations ± S.D. LEGEND: SP = Spaghetti, VP = Vitamin Premix, GN = Groundnut, M = Melon, S = Soybean.

Table 2: Serum biochemical data on test animals fed different diets

Diets	*Animal*	Mean values (m/Mol) of					
		$[Na^+]$	*$[K^+]$*	*$[Ca^{2+}]$*	*Cholesterol*	*Phosphate*	*Protein*
Cerelac Control	A	142.00 ± 0.01	5.00 ± 0.01	8.00 ± 0.03	110.00 ± 0.03	6.80 ± 0.01	6.80 ± 0.10b
SP + VP	B	144.97 ± 0.00	5.33 ± 0.01	6.13 ± 0.03	75.33 ± 1.56	4.20 ± 0.00	2.06 ± 0.10
SP + VP + M	C	145.94 ± 0.01	5.57 ± 0.01	8.83 ± 0.00	112.80 ± 1.61	4.93 ± 0.02	6.67 ± 0.03 b
SP + VP + GN	D	143.90 ± 0.02	4.83 ± 0.00	9.00 ± 0.01	113.33 ± 0.22	6.13 ± 0.00	9.29 ± 0.01a
SP + VP + S	E	139.93 ± 0.02	5.03 ± 0.03	9.09 ± 0.02	119.93 ± 0.01	4.87 ± 0.00	9.78 ± 0.01a

Values are Means of four determinations ± SD. Means with the same subscript are not significantly different at $p<0.05$ LEGEND: SP = Spaghetti, VP = Vitamin Premix, GN = Groundnut, M = Melon, S = Soybean.

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Table 3: Duncan's multiple range test for sensory evaluation of Spaghetti fortified with protein sources.

Diet	Storage Time (weeks)	Colour	Mouth Feel	External Appearance	General Acceptability
A Cerelac (Control)	0	34.00	34.00	33.00	34.00
	4	33.50	33.00	33.00	33.00
	8	33.00	32.00	33.00	33.00
	12	34.00	33.00	33.00	33.00
B SP + VP	0	31.50	29.50a	31.00a	3100a
	4	31.00	28.00a	30.25a	31.00a
	8	30.50	29.50a	31.75a	31.50a
	12	31.00	28.50a	31.00a	31.00a
C SP + VP + M	0	28.50a	30.40a	29.45a	30.40a
	4	27.00a	29.50a	28.25a	30.00a
	8	30.50a	29.00a	30.75a	2950a
	12	29.50ab	28.00a	29.00a	28.00a
D SP + VP + GN	0	32.10a	31.50a	31.50a	32.50a
	4	31.20a	30.50a	30.75a	33.00a
	8	32.00a	30.50a	31.25a	33.00a
	12	32.70a	32.10a	32.50a	32.50a
E SP + VP + S	0	32.50a	31.50	32.10a	32.50a
	4	33.00a	30.00	21.20a	33.00a
	8	33.00a	30.50	32.00a	32.00a
	12	32.50a	29.50	32.70a	32.50a

Values are totals of 5 panelists. Totals having the same letter for the same storage time are not significantly different. ($p < 0.05$). 05 LEGEND: SP = Spaghetti, VP = Vitamin Premix, GN = Groundnut, M = Melon, S = Soybean.