American Journal of

Food Technology

ISSN 1557-4571

Academic
Journals Inc.

www.academicjournals.com

American Journal of Food Technology 2 (6): 477-489, 2007
ISSN 1557-4571

Formulation and Nutritional Quality of Extruded Weaning Food Supplemented with Whole Egg Powder

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Abstract: Sample of extruded high protein weaning foods were formulated at different ratios using blends of rice, soybean, carrot, whole egg and maltodextrin to achieve the desire level of protein. The extruded based on pre-roast mix of the raw seeds with whole egg and maltodextrin were developed and characterized in terms of the hot paste viscosity chemical and nutritional quality, amino acid composition, nitrogen solubility and sensory. Comparative evaluations of the three extruded products were undertaken on the commercial weaning food and the national standards of China GB 10770-1997. In general, the extruded products were found to have better nutritional quality as indicated by the high protein content 17.16, 18.38 and 18.05%, respectively for formulations TWF_1, TWF_2 and TWF_3 and quality. They had also excellent physical properties and sensory of the three local extruded weaning foods. However, the seeds treatment was found to reduce the quality characteristics of the extruded products.

Key words: Extrusion, nutritional quality, sensory, complementary weaning food

INTRODUCTION

Today, more than 20 years after the Universal Declaration on Eradication of Hunger and Malnutrition adopted by the World Conference, more than 65 million children die every year as a result of malnutrition (UNICEF, 1998). However, it does not account for the million lucky enough to be alive, but who are mentally retarded owing to malnutrition. The problem in most cases is not a simple lack of food, but rather an inadequate supply of energy and nutrients.

In developing countries, where malnourished children are usually found, most problems start during weaning. Children are often weaned on starchy, bulky gruels which have both low energy and low nutrient density (King and Ahworth, 1991). Most of weaning foods in developing countries are based on cereals (mainly, maize, yam, millet, sorghum and other family diets) without adequate supplementation with high quality protein sources (Nnanyelugo, 1985). Over dependence on such poor protein sources is the main cause for the widespread protein-energy malnutrition problems in these areas. The low cost, energy and nutrient rich infant foods is a constant challenge in developing countries. Low cost extrusion cooking has been studied in a number of countries with encouraging success (Camire *et al*., 1990) and could offer the ever-elusive solution to the malnutrition problem. But this application did not include local resources in these developing countries such as carrot and whole egg powder.

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Extending the same technology to these non-grain starchy staples would help broaden the caloric sources, especially if they are blended with other foods. Cereal (rice), the main source of calorie in developing countries' diets, is adequate in methionine and cysteine but limiting in lysine. Legume (soybean) is rich in lysine but low in methionine and cysteine and for weaning food, especially those where soy protein is an ingredient, factors such as trypsin inhibitor activity, energy and nutrient availability and physical parameters such as colour are important. Thus, carrot is still the major single source of vitamin A, occurring in nature in precursor form as α-, β- and -λ carotene.

Whole egg is a good supplement because it is the most complete food available in nature. Egg protein is of such high quality and hence used as a standard by which other proteins can be compared. It has a biological value (efficacy with which protein is used for growth) of 93.7%. Comparable values are 84.5% for milk, 76% for fish and 74.3% for beef. Eggs are the best protein source for infant formulas and contain many other valuable vitamins and minerals (Wilson *et al*., 1998).

Low-cost extrusion cooking is a versatile food processing technology that rapidly mixes and kneads feed material at temperatures of over 100°C, to cook and dry the product in a relatively short time (Moquet *et al*., 2003). This thermal process improves the nutritional quality of the raw food material and eliminates vegetative microorganisms. In this study, simple indigenous techniques of food processing such as shelling and toasting were combined with low-cost extrusion to create an experimental product that could be produced on a large scale as developing countries based on sustained effort.

This study is therefore part of exploratory work towards this goal. The aim of the study is to formulate some composite blends based on cereals like rice, legumes like Soybeans and vegetable like carrot, with whole egg powder and then chemically evaluate their respective nutritive values. Nitrogen solubility, thermal properties, pasting characteristics and sensory of the formulated blends were evaluated.

MATERIALS AND METHODS

Materials

Rice (*Oryza sativa*), Soybeans (*Glycine max*), Carrot (*Dacus carota*) used for blend formulations and extrusion in the study were obtained from a local market in Wuxi China, in October 2006.

Whole egg powder was purchased from Da Lian LuXue Co. Ltd. (Shanghai) and the maltodextrin was obtained from Xiwang Starch Co. Ltd. (Binzhou). The blend preparations of rice, soybean and carrot were based on previous work as follow on Fig. 1 a-c.

Formulations

An algebraic calculation was able to provide formulations (WF_1, WF_2 and WF_3) that best fit the nutrient requirements for a weaning infant by successive approximation. A 100 g portion of each of these mixtures was formulated to provide the daily energy requirement, three-quarters of daily requirement for protein and contribute at least two-thirds of daily requirement of other essential nutrients for 6-12 months old. These estimations were based on recommendations of National standards of China. GB10770-1997 for the formulations of infant food composed mainly of plant/animal protein for the purposes of nutrition intervention in developing countries (Junshi, 1997). The ingredient ratios were done using the nutrient and caloric values (Table 1).

After the composition of the mix to be used has been decided upon, the next step was to calculate the amount of each ingredient which was to be used. This first part of work was done with great care for two very important raisons. First, a satisfactory quality in the finished product was possible only when the proper proportion of constituents was used in the mix. Second important reason for giving so much attention to the calculation to the calculation and preparation of the mix pertained to the cost. There were several methods by which this calculation may be done. The use by algebraic equations,

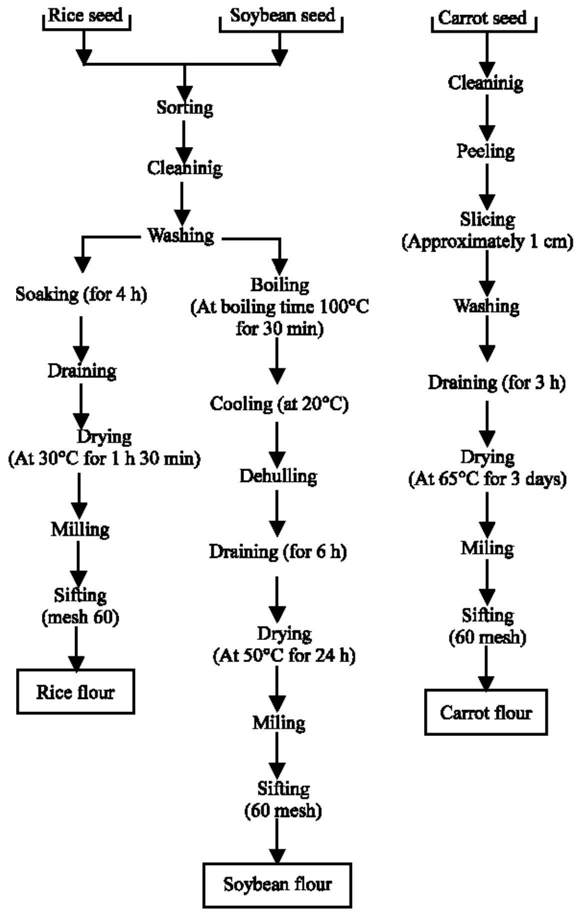

Fig. 1 a-c: Flow diagram for the preparation of the flour of raw materials from rice, soybean and carrot

Table 1: The nutrient content of used raw materials for infant formula (%)

	Nutrient content (g/100 g raw material)				
Raw materials	Protein	Fat	Carbohydrate	Moisture	Ash
Rice (x)	7.32	0.38	82.43	9.52	0.35
Soybean (y)	43.82	11.16	34.26	9.42	6.25
Whole egg (z)	43.85	47.38	-	4.15	3.37
Carrot (p)	-	-	73.35	11.72	7.02
Maltodextrin (u)	-	-	90.0	10.0	-
Expected quantity in final product (%)	18.0	19.0	458.0	4.0	5.0

however, gave the exact amount, while others were more of approximation.
Calculation of the mix for the infant formula:

Let x = Amount of rice in the mix
y = Amount of soybean in the mix
z = Amount of carrot in the mix
p = Amount of whole egg
u = Amount of maltodextrin in the mix

To find the amounts of the ingredients needed, 5 simultaneous equations, which involved the same unknowns, were formed as follows:
Weaning Formula (WF_1), ratio: 1:1

$$\begin{cases} 0.732\,x + 0.438\,y = 0.4385\,z & (1) \\ 0.732\,x + 0.438\,y + 0.4385\,z = 18\% & (2) \\ 0.0038\,x + 0.1116\,y + 0.4738\,z + p + u = 10\% & (3) \\ 0.8243\,x + 0.3426\,y + 0.7335\,p + 0.90\,u = 67\% & (4) \\ 0.9048\,x + 0.9058\,y + 0.9585\,z + 0.8828\,p + 0.9\,u = 97\% & (5) \end{cases}$$

Weaning Formula (WF_2), ratio: 1:2

$$\begin{cases} 0.732\,x + 0.438\,y = 2\times0.4385\,z & (6) \\ 0.732\,x + 0.438\,y + 0.4385\,z = 18\% & (7) \\ 0.0038\,x + 0.1116\,y + 0.4738\,z + p + u = 10\% & (8) \\ 0.8243\,x + 0.3426\,y + 0.7335\,p + 0.90\,u = 67\% & (9) \\ 0.9048\,x + 0.9058\,y + 0.9585\,z + 0.8828\,p + 0.9\,u = 97\% & (10) \end{cases}$$

Weaning Formula (WF_3), ratio: 1:3

$$\begin{cases} 0.732\,x + 0.438\,y = 3\times0.4385\,z & (11) \\ 0.732\,x + 0.438\,y + 0.4385\,z = 18\% & (12) \\ 0.0038\,x + 0.1116\,y + 0.4738\,z + p + u = 10\% & (13) \\ 0.8243\,x + 0.3426\,y + 0.7335\,p + 0.90\,u = 67\% & (14) \\ 0.9048\,x + 0.9058\,y + 0.9585\,z + 0.8828\,p + 0.9\,u = 97\% & (15) \end{cases}$$

Of these: Eq. 1 gave the animal/plant protein
Eq. 2 was the protein equation
Eq. 3 was the fat equation
Eq. 4 was the carbohydrate equation
Eq. 5 was the representation of total mix

The amount of each ingredient to be used was got by solving these three systems of equation. Final results showed in Table 2.

Extrusion Process

The blend was extruded using a co-rotating twin screw extruder; model A DS-32-II (Jinan Food Machinery China) with a smooth barrel. The extruder has three independent zones and the effective cooking zone temperatures were set to 100, 110 and 120°C, respectively for zones 1, 2 and 3 in the barrel. The length to diameter (L/D) ratio for extruder was ≈ 20:1. The diameter of the hole in the die was 6mm with a die length of 27 mm. Temperature profile in the feed and compression metering zone were kept out constant at 55 and 75°C, respectively.

Table 2: Ingredient quantities (w/w) of formulated of weaning food

Ingredient	WF_1	WF_2	WF_3
Rice	48	50	48.5
Soybean	17	12	8.5
Carrot	1.5	1.5	1.5
Whole egg	17	22	25.5
Maltodextrin	16	14.5	16

The various grits were mixed gently and the moisture adjusted by the addition a pre-determined amount of the water (10-14% moisture). The mixing was done by hand protected by plastic glove at the laboratory requirement. A face cutter was used to cut extrudates as they left the extrusion die. The extrudates were collected and dried in oven air at 120°C for 5 min. The product was cooled and tempered at 4°C before being stored into plastic bags for further analysis.

Chemical Analysis

Samples of each blend were analyzed for moisture, fat, protein, ash, lipids and carbohydrate according to AOAC methods (Association of the Official Analytical Chemists, Washington USA) (AOAC, 1995).

Minerals content were analyzed using an atomic absorption spectrophotometer (Perkin Elmer). Phosphorus was determined using a spectrometer at wavelength 690 nm. Energy conversion factors were used in calculating the calorific value of the nutrients (Ceirwyn, 1995).

Thermal Analysis

Thermal analysis of weaning food proteins was done according to the method reported by (Sorgentini, 1995; Harwalkar *et al*., 1987) with some modifications. The thermal behavior of the proteins from weaning food was examined with a Perkin Elmer Model PYRIS 1-DSC Differential Scanning Calorimeter.

Pasting Properties

The pasting properties of the extruded traditional weaning foods were evaluated using a Micro Visco-amilograph (Brabender OHG Duisburg D-47055 Duisburg, Type: 803201 Germany). Flour slurry containing 10% solids (w/w, dry basis) was heated from 30 to 95°C at the rate of 5.0°C min^{-1}, held at 95°C for 15 min and cooled at the same rate to 50°C. The pasting properties (pasting temperature, peak viscosity, viscosity at 95°C, stability, cooking time and setback viscosity) were recorded by amylograph.

Nitrogen Solubility

Nitrogen solubility was determined according to the method cited by (Bera and Mukherjee, 1989), with some modification. Nitrogen contents in supernatants were determined by Kjeldahl method. The percentage of nitrogen solubility in each suspension was calculated using Eq. 16:

$$NS(\%) = \frac{P_S}{P_M} \times 100 \qquad (16)$$

Where: P_S is amount of nitrogen in supernatant
P_M is amount of nitrogen in sample

Amino Acid Analysis

Amino acids were analyzed according to the procedure by Osborne *et al*. (1978) and Salunkhe *et al*. (1992).

Sensory Evaluation

The sensory evaluation was carried out on the following sensory attributes: Taste, appearance, aroma, mouth (texture), colour and overall acceptability by the panel of ten members using a 9-point Hedonic scale. The rating of the samples ranged from 1 (Dislike extremely) to 9 (Like extremely) was the one described by Ruston *et al*. (1996).

Statistical Analysis

The results are presented as mean values and standard deviations of triplicate analyses. Data were subjected to one-way analysis of variance (ANOVA) the difference was considered to be significant at $p<0.05$. Mean were separated using Duncan's multiple range tests.

RESULTS AND DISCUSSION

The proximate nutrient composition of the three extruded weaning foods and commercial weaning food are presented in Table 3. The results indicated that moisture, fat and energy values were higher in all the three extruded weaning foods than in Commercial Weaning Food (CWF) product and were not significantly different ($p<0.05$) to each other. These results were similar to those reported by Plahar *et al*. (2003). Protein was also higher in WF_2 and WF_3 than in CW and significantly different to WF_1 but similar to the result reported by Plahar *et al*. (2003). There was no significant difference ($p<0.05$) for the ash contents of the samples. Similar result was reported by (Mosha *et al*., 2000). By the way, the ash contents of CWF was closely the same that those of the samples.

Having shown that most of the nutrient values were higher in the three extruded weaning food blends than in CW product (Fig. 2), again, a dry basis of the extruded weaning foods of the formulations were calculated and compared to National standards of China for the same age groups (Junchi, 1997). The comparison result is presented in Table 3. The amounts of protein provided of WF_2 and WF_3 understudied the CSN value (≥ 15), for infants up to 1 year of age. WF_1 (17.16%) is also higher of protein content than in CWF, comparable to NSC level and significantly different to WF_2 and WF_3. The higher protein content in WF_2 and WF_3 could be attributed to the positive contribution of whole egg powder and Soybean to protein nutritive. Crude fat contents in all the three WF were 18.11, 18.19 and 18.14%, respectively and met the NSC values. However, the energy content of all the three WF was compared to that of NSC values and significantly differed with energy contents

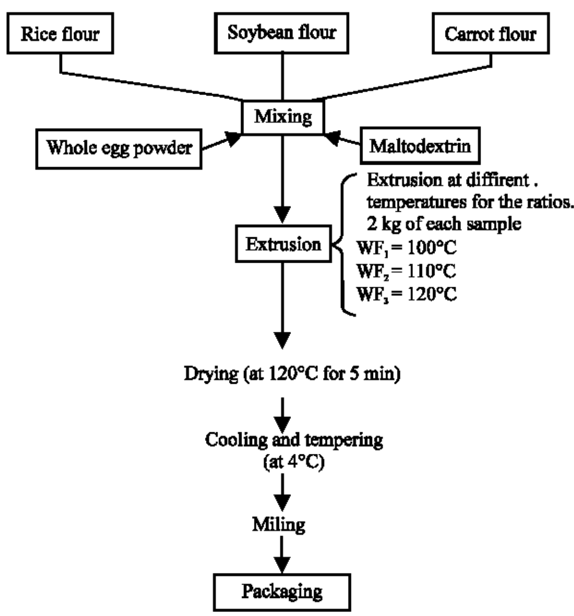

Fig. 2: Flow diagram for the preparation of extruded weaning foods from the ratios WF_1, WF_2 and WF_3

in CWF. This attribute tends to agree with the recommendations of (FAO/WHO, 1998) that vegetable oils most be included in foods meant for infants and children, which will not only increase the energy density, but also be a transport vehicle for fat soluble vitamins. The fat can also provide essential fatty acids like that of n-3 and n-6 Polyunsaturated Fatty Acids (PFA's) needed to ensure proper neural development. Even though the fatty acid composition of the three extruded weaning foods were not determined, research carried out by Fernandez *et al*. (2002) on the fatty acid composition of some developing countries weaning foods, revealed that the foods were devoid of arachidonic and decosahexanoic acids, but high in linoleic and linolenic acids.

Iron and zinc were high values in the three extruded formulations than in CWF product and significantly ($p<0.05$) different to each other (Table 3). When calcium and phosphorus fell down against the values in CWF and were significantly different, while magnesium had high values than that in NSC. These results were similar to those reported by Ijarotinmi and Ashipa (2005). Understandably, the higher mineral contents of CWF product could be attributed to fortification practices normally carried out on such products.

Amino Acid Analysis

The diets contain all the essential amino acids (Table 4). The comparison of the essential amino acids to the IOM reference values (IOM, 2000). This comparison revealed that WF_2 and WF_3 contained lower scores of most essential amino acids than WF_1. Thus, all the three extruded formulations did not meet the IOM value. This therefore means that all of the essential amino acids fell short of the reference values. Amino acid content of complementary foods is a particular relevant issue in infant feeding, where Protein-Energy-Malnutrition (PEM) has continued to pose challenges in the research area. This, according to other researchers, is due to poor feeding practices and low

Table 3: Proximate composition (%), energy content (Kcal) of TWF[1]*, CWF and FAO/WHO standards

Nutrients	TWF_1	TWF_2	TWF_3	CWF[2]	NSC[3]
Moisture	8.06 ± 0.04^{a}	8.09 ± 0.28^{a}	8.04 ± 0.06^{a}	5.0	≤5.00
Protein	17.16 ± 0.04^{b}	18.38 ± 0.02^{a}	18.05 ± 0.09^{a}	15.0	≥15.00
Fat	18.13 ± 0.95^{a}	18.69 ± 0.66^{a}	18.54 ± 0.59^{a}	7.1	≥12.00
Ash	4.98 ± 0.20^{ab}	4.56 ± 0.13^{ab}	4.67 ± 0.19^{ab}	5.0	≤5.00
Carbohydrate	55.57 ± 0.9	54.08 ± 0.13^{b}	54.60 ± 0.64^{ab}	33.8	≥60.00
Energy	457.59 ± 0.36^{ab}	458.05 ± 0.73^{a}	457.66 ± 0.30^{ab}	373.8	≥408.00
Iron	12.28 ± 0.80^{c}	14.42 ± 0.30^{a}	13.23 ± 0.82^{b}	10.0	≥6.00
Zinc	7.12 ± 0.70^{c}	16.19 ± 0.20^{a}	9.31 ± 0.68^{b}	4.0	3±7.00
Calcium	57.42 ± 0.89^{c}	62.12 ± 0.24^{a}	60.30 ± 0.28^{b}	680.0	≥360.00
Magnesium	60.04 ± 0.94^{c}	81.80 ± 0.35^{b}	71.82 ± 0.61^{a}	-	29.03
Phosphorus	105.25 ± 0.85^{c}	120.20 ± 0.51^{b}	235.85 ± 0.73^{a}	480.0	≥180.00

[1]Means±standard deviation of three determinations. All values are expressed on dry weight basis. *Means within a row with different alphabets are significantly different. [2]Commercial Weaning Food from Wuxi supermarket in China, values indicated by manufacturer. [3]National Standard of China (GB10770-1997) for follow-up/weaning foods (Jinshi, 1997)

Table 4: Amino acid composition of the three traditional weaning food (TWF) diets, commercial weaning food (CWF) and IOM standards ($mg\ g^{-1}$)

Amino acids	WF_1	WF_2	WF_3	IOM[a]
Lysine	7.94	6.42	6.39	51
Threonine	5.71	5.76	6.39	43
Valine	8.72	6.99	8.18	32
Histidine	8.60	6.47	6.85	18
Methionine + Cysteine	5.62	13.17	13.56	25
Isoleucine	6.21	4.77	5.51	25
Leucine	1.02	1.61	1.70	55
Phenylalanine + Tyrosine	13.63	13.54	15.03	47
Tryptophan	4.92	3.92	4.13	7

[a]IOM = Based on Estimated Average Requirements for 1-3 year-old children for both indispensable amino acids and total protein

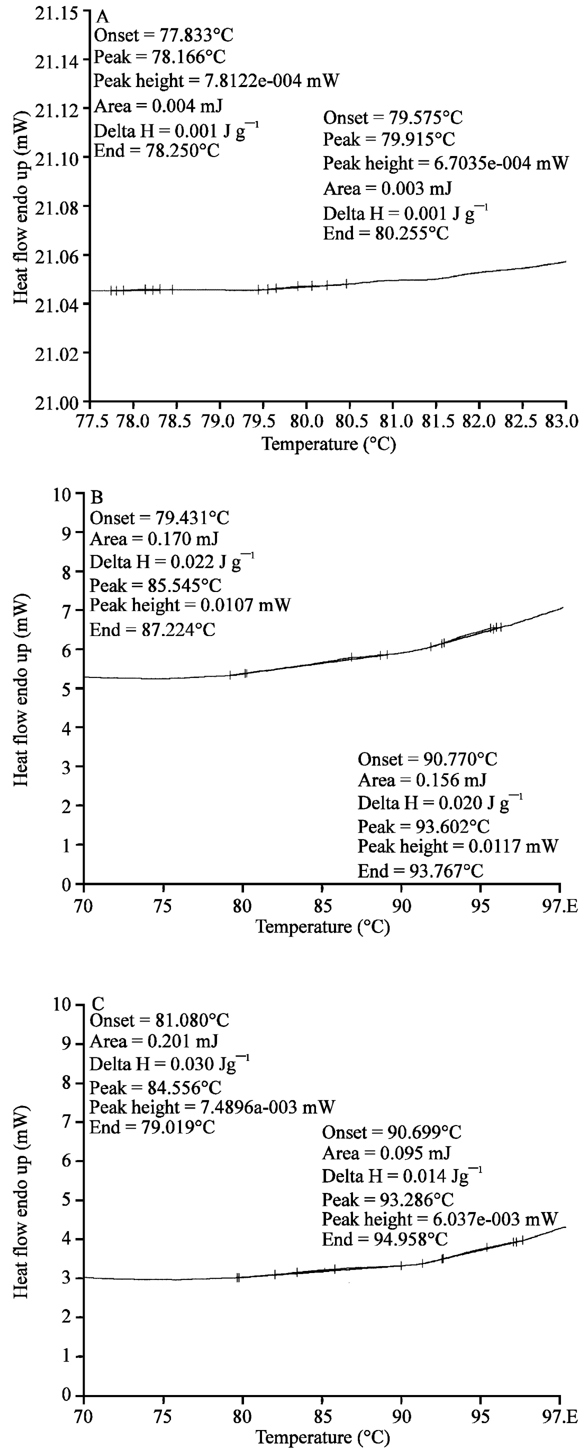

Fig. 3: DSC thermograms of extruded weaning food protein. (a) DSC thermogram of WF_1 proteins (b) DSC thermogram of WF_2 proteins and (c) DSC thermogram of WF_3 proteins

quality protein commonly associated with plant-based single diets (Temple *et al*., 1996; Fernandez *et al*., 2002). All the essential amino acids were present in the three local diets, but quite a number of them did not meet the IOM reference values. This short-fall is a matter of concern as this will tend to limit the utilization of the amino acids in the metabolic processes of the body (AOAC, 1990). Diets composed of cereals/legumes mixed with some animal protein source (17-25.5%), had been reported to be sufficiently high in amino acids to meet RNI's (Recommended Nutrient Intakes) (FAO/WHO, 1998). For instance WF_1, which contained about 17% whole egg powder, showed higher amino acid contents than the other two diets, which is the base agreement in line with above mentioned observations.

Thermal Analysis

A WF_1 protein (Fig. 3a), showed a sharp endothermic peak with a T_d of 78.166°C and denaturation enthalpy ΔH of 0.001 J g^{-1}. Test indicated that WF_1 protein after extrusion, lost its thermal response after heating at 79°C and a rescan of the heated sample showed new peaks. Hence, a T_d of 79.916°C with a same value of ΔH and it lost thermal response after heating to 83°C.

WF_2 and WF_3 proteins (Fig. 3 b and c) showed sharp endothermic peaks with T_d of 85.545 and 84.556°C and ΔH of 0.022 and 0.030 J g^{-1}, respectively. The protein in WF_2 and WF_3 showed broad peaks thermograms with T_d of 93.602 and 93.286°C which were higher than that in WF_2 and WF_3 protein, ΔH were 0.020 and 0.014 J g^{-1}, respectively. Consequently, the protein in WF_1 was considerably lower than that the protein in WF_2 and WF_3.

The results suggest that the high values of T_d with WF_2 and WF_3 are heated stable requiring relatively high temperature to de nature.

Pasting Characteristics

The amylograms of three formulated local diet blends were re-plotted on orthogonal coordinates and supposed comparison (Fig. 4). Individual values for pasting temperature, pasting time, peak viscosity, viscosity at 95°C, 15 min height, paste stability, viscosity at 50°C, set back viscosity and cooking time were also shown in Table 5.

The local diet blends TWF_1 showed a gelatinization temperature similar to that of TWF_3 blends while a faster gelatinization was achieved with the TWF_2 blend. This is an indication of hardening effect of individual ingredients in the samples and consequent slow solubility of starch granules. In

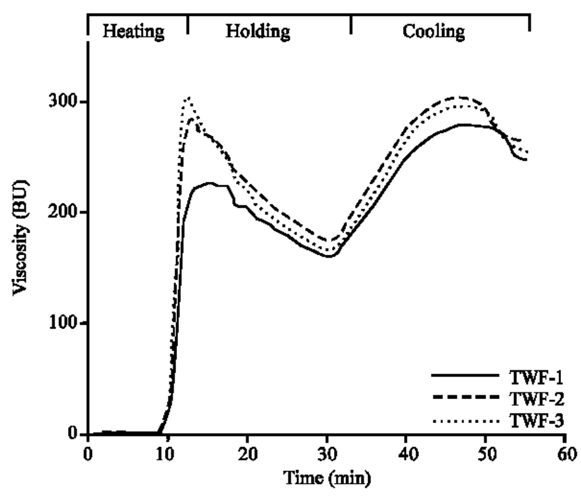

Fig. 4: Amilograph pasting characteristics of extruded weaning food formulations

Table 5: Sensory evaluation scores of extruded weaning foods and commercial weaning formular[1],*

Sample	Appearance	Taste	Aroma	Mouth feel	Acceptability
WF_1	2.5±0.14[a]	3.7±0.22[a]	4.1±0.12[ac]	4.1±0.12[abc]	3.5±0.18[a]
WF_2	4.7±0.21[bc]	4.4±0.23[bc]	5.0±0.23[bd]	4.3±0.15[abc]	4.9±0.20[bd]
WF_3	4.6±0.13[bc]	4.1±0.32[bc]	4.3±0.36[ac]	4.4±0.11[abc]	4.9±0.12[cd]
CWF	5.7±0.18[d]	5.9±0.34[d]	5.9±0.42[d]	5.3±0.01[d]	5.1±0.02[d]

[1]Mean±standard deviation for three determinations. *Means within a column within similar alphabets are not significantly different ($p<0.05$). CWF = Commercial Weaning Food from Wuxi supermarket, China

general, all the local weaning blends produced amylograms with viscosities that were typical of products that had received some degree of heat treatment during preparation. Such products are characterized by relatively low pasting viscosities with no clear-cut peaks.

In the present study, only TWF_3 blend showed peaks similar to what is normally observed with TWF_2 products like nutritional quality of extruded weaning foods based on peanut, maize and soybean (Plahar *et al.*, 2003).

This is an indication of relatively low heat treatment to which the extruded raw blends had been subjected. The TWF_2 produced only a peak of 301 BU and continued to increase in viscosity on further heating. The lower pasting viscosity observed in the TWF_1 and TWF_3 blend samples were resulted from supplementation with low starch materials such as whole egg powder and other ingredients which diluted the starch concentration in the blend.

Prolonged cooking at 95°C for 15 min resulted in reduced viscosity for only TWF_1 blend. Both the TWF_2 and TWF_3 blends showed some resistance of starch to prolonged heating while TWF_2 blend samples continued to increase in viscosity. The least value for paste stability was obtained with the TWF_1 blend samples because of the continued decrease in viscosity during holding. Cooking time ranged between 2:30 and 3:60 min with minimum time for ease of cooking recorded in blends.

Hot paste viscosity characteristics of weaning foods, as determined from such amylograms, give an indication of the starch behavior and the rheological characteristics of the cooked product. Viscosity plays a very important role in the acceptability of the product. An acceptable weaning food is supposed to develop into a paste-like porridge when cooked and become moderately viscous. Watery non-viscous slurry is not acceptable traditionally. In weaning food formulations therefore, it is quite important to ensure that an acceptable degree of viscosity is attained in the cooked product. In the present study, although the starch strength of the traditional extruded weaning foods was slightly reduced by the incorporation of the high protein base supplementation materials, the hot paste viscosities obtained were similar to those of the commercial weaning food samples and within acceptable limits.

Moreover, it is an advantage in terms of increased nutrient density to increase the concentration of the product in slurry to be cooked in order to achieve the desired viscosity.

Nitrogen Solubility

The nitrogen solubility of the three extruded weaning food over range of pH 2-10 are presented in Fig. 5. Minimum solubilities were shown at pH 4.0-6.0 and high solubilities above pH 7.0 and at pH 2.0, which coincide with curves, reported previously by (Mensa-Wilmot *et al.*, 2001).

The Food and Agricultural Organization and the World Health Organization (FAO/WHO, 1998) have also recommended that foods fed to infants and children should be energy-dense ones. This, according to the recommendation, is necessary because low energy foods tend to limit total energy intake and the utilization of other nutrients as mentioned above. However, the total calculated energy values in the three extruded diets fell below the RDA (recommended Dietary Allowance) level. This suggests that infants may have to consume more quantities of the diets to meet their energy needs, which is often an impossible task considering the size of their stomach. Therefore, reformulation of the diets may be necessary to increase the carbohydrate content of the diets, which is particularly low in the three extruded weaning foods.

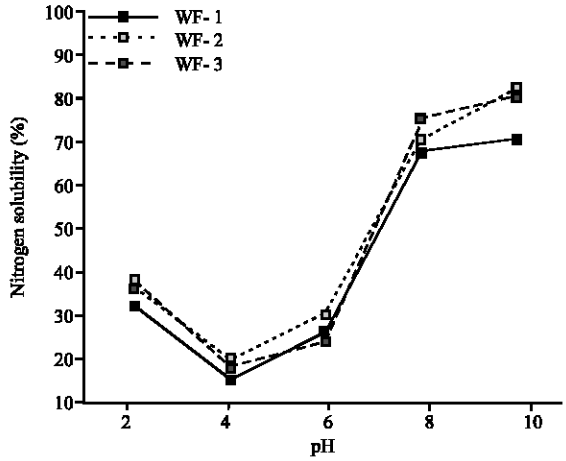

Fig. 5: Nitrogen solubility profile of extruded weaning food blends

Sensory

It was observed that there was a significant difference between the CWF and formulated weaning food flours in term of overall acceptability (Table 5). The CWF was rated higher than the extruded weaning flours. This could be attributed to the fact that consumers were used to extruded weaning food sample, which consist of soybean and whole egg powder. The WF_3 of 25.5% whole egg powder supplementation was rated next to the control food sample, but there was no significant different between it and the WF_2 of 22% whole egg powder supplementation in overall acceptability and also in term of meeting the FAO/WHO requirement of the infants. This suggests that supplementation above 17% whole egg protein only caused minimal alteration in the nutritive value of whole egg powder. It is, therefore, suggested that 22 and 25.5% whole egg powder supplementation could be used for weaning food formulation.

CONCLUSION

This study revealed that ready-to-eat complementary food products formulated from locally available food commodities, can meet the macro nutritional needs of infants and children. However certain aspects like the digestibility and bio-availability of the macronutrients in these local diets need further investigation. On the other hand, the formulation diets did not meet the recommended micronutrient (minerals) requirements of infants and children. Therefore, fortification with appropriate micronutrients or micronutrient-dense foodstuffs will be necessary.

Thus, such local diets can fairly substitute the more expensive proprietary formula products, the researchers believe that complementary foods formulated from locally available food commodities, have great potential in this aspect. The results from this study suggest that proper reformulation and fortification of local diets can provide nutritious foods that are suitable not only for weaning, but also as rehabilitation diet to malnourished children that can be more cost effective. This is believed to be a practical food based approach aimed at combating the problem of malnutrition among infants and children in developing countries.

ACKNOWLEDGMENT

Extrusion cooking was carried out at the Technological Research of Southern Yangtze University, Wuxi, China. The nutritional evaluation was done at the Department of Testing and Analyzing Center in Southern Yangtze University. Financial support was provided by Key Laboratory of Food Science and Safety, Ministry of Education, Wuxi, China.

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