

Functional, Organoleptic Properties and Nutrients Composition of Imitation Egg Powder Produced from Suitable Natural Raw Materials

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ABSTRACT: Five different samples of imitation egg powder were produced from natural raw materials (Soybean, white cowpea, wheat gluten, melon, yellow sweet potato and trifoliolate yam, each converted into flour) obtained from Anyigba, Nigeria. They were coded samples 101, 201, 301, 401 and 501 containing cowpea and soy content in ratios 1:1, 2:1, 1:2, 3:2 and 2:3 respectively, while the proportion of other ingredients remained the same in each sample. Commercial whole egg powder (sample 601) was provided as the control. Each sample was packaged in HDPE bag, kept under refrigeration not longer than 4 weeks for functional property, sensory evaluation, nutrients composition and statistical data analysis using standard methods. The range values of bulk density, foaming capacity and wettability of imitation egg samples were 0.40–0.45 g/mL; 30.0–41.00%; 6.1–7.17s respectively. While the corresponding values for sample 601 (the control, whole egg powder) are 0.51g/mL, 40.0% and 6.20s which did not constitute any significant difference ($p \leq 0.05$) among the samples. The five imitation egg samples had water hydration, oil absorption, emulsification and gelation capacities with range values of 1.40–1.80 mL/g; 2.20–2.60mL/g, 44.0–44.8% and 5.0–6.5% respectively. However, control sample 601 had highest value of emulsification and gelation capacities, which were not found to be significantly different ($p < 0.05$) from those of egg substitute samples. Imitation egg samples 101, 201 and 601 (control) had similar colour ratings (5.46–5.92 range), which were not significantly different from those of 301, 401 and 501. Also, samples 101, 201, 301, 501 and 601 (control) had similar flavour and taste mean scores (5.4–6.04 and 5.20–5.78 respectively), while all the samples including the control had similar texture and mouthfeel scores. Moisture content of egg substitute samples ranged from 6.62–6.80% (db), crude protein (31.72–43.15%, samples 401 and 501 values found, higher than the control, ash (2.25–4.15%), crude fibre (0.61–1.50%, whole egg powder with 0.01%), crude fat (12.01–16.40% range, and control with 10.94%), total carbohydrates (35.30–38.52%), beta carotene (163.5–193.1mg/100g, highest in sample 301). Sample 101 containing cowpea and soybean flour in ratio 1:1 shared the most similar functional, sensory and nutrient content properties with sample 601 (whole egg powder) and therefore adjudged to be the most desirable egg substitute powder that resembled natural whole egg powder.

KEYWORDS: Egg substitute powder, natural raw materials, egg functional properties, sensory attributes and nutrient composition.

I. INTRODUCTION

Natural edible egg is an animal – based product, laid by birds such as hen, duck, turkey, quail and composed of egg white or albumin (about 62%) and yolk (38%). A typical egg has balanced food nutrients, containing proteins (13.78%), fat (12.49%) carbohydrates (4.25%), vitamins (6.35%), ash as minerals (2.84%) and water (75.2%). It is a rich source of complete amino acids[1]. The presence of cholesterol and anti-nutrients (such as avidin and allergins) in eggs limits its nutritional benefits. For instance, avidin has been shown to inhibit biotin vitamin absorption, which is necessary for fatty acid synthesis and blood sugar regulation, and neither frying nor boiling can destroy it completely[2]. Again, it has been reported that some people show allergic reaction to egg consumption. According to reports[3], eggs have been shown to serve various functions in food as binder, thickener, agent for coating, foaming,

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leavening and emulsification, nutrient fortifier and colourant due to the presence of the albumin and yolk components that confer such functional properties on whole egg.

In recent times, it has been reported that the quantity of eggs produced in most countries is insufficient to meet the requirement of the populations, especially African states and sub-region. Intensified research into the development of egg substitute products to mimic natural, using natural raw materials is worthwhile. Such imitation or analogue egg products would be cholesterol and anti-nutrient free, constitutes no allergin, able to furnish or supply balanced nutrients, possess functional properties similar to egg, and be made available in substantial quantities to meet world consumer requirements when combined with insufficient production output.

Therefore, the main purpose of this work was to produce and evaluate the functional properties, sensory attributes and nutrients composition of egg substitute powder products using natural raw materials such as soybeans (36.4% proteins), cowpea (22.7% protein), wheat gluten (100% protein), yellow fleshed potato (20.1% carbohydrates), trifoliolate yam (37.4% carbohydrates), melon (7% protein, 14.5% fat), taste enhancer (table salt), egg flavour, antioxidant and preservative.

II. RELATED WORK

An egg substitute is a product that can be used as a replacement for fresh eggs in order to reduce or eliminate the cholesterol content and allergen found in eggs. It contains ingredients that mimic the functions of egg in binding, thickening and leavening[3]. Two types of substitute have been identified and produced, including complete egg substitute made from soymilk as protein source (equivalent in biological value to animal protein), which cannot be used in recipes where egg is required for thickening and another substitute containing egg white, in which the egg yolk has been replaced with vegetables and milk product. Often, egg substitutes are fortified with vitamins and minerals found in natural egg yolk. Most of the egg substitute powders are produced from raw ingredients such as soybean (soy flour for protein and fat), wheat (gluten protein), cowpea (protein and carbohydrates), artificial flavour and colouring, all contribute to stimulate the texture, flavour, colour and taste of eggs. According to USDA nutritional facts, a typical egg substitute powder has nutrients composition per 100g sample of protein (55g), total fat (13g), total carbohydrates (21g), dietary fibre (0g), cholesterol (0g), potassium (744mg), calories (444 kcal)[2, 3], and it has been reported that the use of egg substitutes enables people to enjoy their food without any concern for negative impact on their lives and they are healthy alternative to natural egg for cooking and baking.

III. MATERIALS AND METHODS

A. Sources of raw materials

Soybeans, white cowpea and wheat gluten (as sources of protein, equivalent in biological value to animal protein) were obtained from Anyigba.

Melon flour (as source of oil and protein, thickening and binding agent), yellow fleshed potato and trifoliolate yam (as sources of soluble carbohydrates, beta carotene and yellow colour) were also obtained from Anyigba market, Nigeria. Others include: sodium metabisulphite, propyl gallate, whole egg powder and egg flavour, which were obtained from reputable stores in Lagos - Nigeria.

B. Raw Material Preparation

Both soybeans and cowpeas were processed into non instant flours according to method described[4]. It involved sorting dry beans, weighing, steeping in water at $28\pm 2^{\circ}\text{C}$ for 1hr; dehulling, steaming at 80°C for 30 minutes, draining and drying (60°C in tray dryer, Bench series model, 4.5 hrs), milling into powder (150–180 microns, 6.7% moisture content, dry weight basis). Trifoliolate yam and sweet potato (yellow flesh variety) were also processed into non – instant flour, similar in particle size to soybeans and cowpea, according to method described[5]. Melon was also prepared into similar powder as described[6].

C. Preparation of egg substitute samples.

Five imitation egg powder samples were prepared including one control sample. Recipe comprised cowpea/soy flour mixture (62%) in five (5) proportion variations, melon (22.5%), Yellow potato/Trifoliolate yam flour (8.5%, equal ratio), wheat gluten (4.0%), egg flavour (2.5%), table salt (0.05%) and propyl gallate (0.45%). The Experimental

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samples were coded and each sample has cowpea ratio soy flour as follows: Sample 101 (ratio 1:1 respectively) 201 (2:1), 301 (1:2), 401 (3:2) 501 (2:3). While sample 601 (whole egg powder) as control 1.0kg of each sample (101, 201, 301, 401, 501) was produced by weighing predetermined mass of each ingredient required, properly mixed to obtain a uniform blend. Then packaged in heat sealed high density polyethylene (HDPE) 0.22mm gauge and kept under refrigeration not longer than 4 weeks for functional property, sensory evaluation and nutrients composition analysis.

D. Procedures for Physical and functional property analysis

i. Water hydration capacity determination

Water absorption or hydration capacity was determined as described[7]. 1 gram of each egg substitute powder and control weighed into a conical graduated centrifuge tube, 10mL distilled water added, mixed, centrifuged at 5,000 rpm for 30mins. Then allowed to stand for 30mins, free water volume was recorded, weights of tube before mixing with water and after decanting were recorded. Volume of water absorbed (mL) = wt. of water absorbed(g) = wt. of tube after decanting (g) – initial wt. before mixing with water (where wt. is weight). Water absorption capacity is expressed as mL water/g powder. Triplicate measurements made for each powder and average recorded.

ii. Bulk density determination

The bulk density of each sample of egg substitute powder was determined according to method described[5]. It is the ratio of unit mass(g) of egg powder to the volume (mL) it occupies, expressed as g/mL. For each sample, 3 separate determinations were made, and average value recorded.

iii. Foaming capacity determination

Foaming capacity of imitation egg and whole egg powder samples were each determined according to method described[9]. 2.0g powder sample was blended as applicable with 100mL distilled water in a warring blender, suspension whipped at 1,600 rpm for 5 minutes. Mixture then poured in a 150mL, measuring cylinder and volume recorded after 30mins.

Foaming capacity = Volume after whipping minus initial volume before whipping divided by volume before, multiplied by 100. It is expressed as percent (%). Average triplicate determinations were taken.

iv. Wettability determination

The method described was used to determine wettability of imitation egg powder samples[9]. 1.0 gram powder was weighed into 20mL graduated cylinder with diameter 1.0cm. Hand palm was placed over the open end and then inverted, and clamped at a 10.0cm height from the surface of a 600mL beaker containing 500mL distilled water. The finger was removed and sample allowed to drop. The time taken(s) for the sample to become wet was taken and recorded as wettability. 3 determinations for each sample were made and average value recorded.

v. Emulsification capacity determination

Each egg powder sample was subjected to emulsification capacity determination as described[7]. 2.0g powder was blended with 25mL distilled water at $28 \pm 2^\circ\text{C}$, for 30s, at 1,600 rpm. Then 25mL ground nut vegetable oil was gradually added, with blending for another 30s, then transferred into a centrifuge tube (model Tx 425) and centrifuged at 1,600rpm for 5mins. Height of whole solution in tube (Amm) and height of emulsified layer, with no separation (Bmm) were taken. Emulsification capacity (%) is expressed as B divided by A, multiplied by 100. Triplicate determinations for each sample were made, and the mean value recorded.

vi. Gelation capacity determination

The gelation capacity of each egg powder sample was determined as described[7]. Sample suspensions (2% - 20% W/V) were prepared each into 5mL distilled water in a test tube, heated for 1hr in boiling water bath, cooled rapidly under running cold tap water, then cooled further at 4°C for 2hrs in the freezer. The least gelation concentration (%) was then determined (as that concentration when the sample from inverted test tube did not fall or slip). An average of 3 determinations was taken in each case.

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vii. Oil absorption capacity determination

Oil absorption was determined as described (7). 1 gram powder was weighed into a conical graduated centrifuge tube, 10mL grand vegetable oil added, mixed, centrifuged (centrifuge 12 bucket/) at 5,000 rpm for 30 minutes then, allowed to stand for 30 Minutes, free oil volume (10 ml) minus free volume recorded, multiplied by the density of grand vegetable oil (0.88g/ml) expressed as g oil/g powder for each sample, triplicate measurements were made and average recorded.

E. Organoleptic property assessment and data analysis

Each sample of imitation egg powder was reconstituted in water (powder: water being 1:3) at $28 \pm 2^\circ\text{C}$, and then fried (using grand vegetable oil) into omelet product as well as control (whole egg powder). Each fried sample was presented for organoleptic /sensory evaluation (colour, flavour, texture, taste and mouthfeel) as described[10], involving 10 untrained judges who are familiar with eating fried egg. A 7-point hedonic scale rating was used. The sensory scores were subjected to data analysis, using ANOVA (analysis of variance) and Tukey's LSD method of mean separation.

F. Chemical Analysis

i. Moisture content determination

Moisture content of samples were determined using oven drying method[7]. Pre-dried evaporating dish was weighed, added 5g powder, transferred to hot air electric oven (model JO2707, Michel England) set at 105°C for 3 hrs, cooled in desiccators for 1hr and weighed.

$$\% \text{ Moisture content (dry weight basis)} = \frac{\text{Loss in sample weight as moisture(g)} \times 100}{\text{Original sample weight(g)} - \text{Loss in Weight(g)}}$$

Triplicate values were obtained for each sample.

ii. Beta carotene (Vitamin A precursor) content determination:

The method described[11] was used to determine beta carotene content. Five gram (5.0g) powder was extracted with 40ml hexane; 60ml ethanol mixture. The mixture then transferred to a separating funnel and swung vigorously after adding 20ml of 20% sodium chloride solution. The mixture was allowed to settle then lower layer was run off. The top layer of hexane containing carotenoids was collected, diluted and the optical density measured using spectronic 20 at 440 nm wavelength. 3 determinations were made for each sample and mean value calculated.

iii. Crude fibre determination

Crude fibre content determination was determined according to the method described[11]. Five gram (5.0g) defatted egg powder was weighed, transferred into 500ml conical flask, 200ml boiling 1.25% H_2SO_4 added, mixture boiled gently for 30 minutes. Then filtered through poplin cloth, rinsed with hot distilled water, cake separated, 200ml boiling 1.5% NaOH added with 2 drops grand vegetable oil to prevent foaming, boiled for another 30 mins, filtered, rinsed four times with hot distilled water and once with 10% HCl, twice with methylated spirit, thrice with petroleum ether. Then drained, residue separated into crucible, dried (105°C), cooled in desicator and weighed ($W_1\text{g}$). Then placed in muffle furnace, Indian 0-1500 $^\circ\text{C}$ (at 300°C for 30 mins), cooled to room temperature and weighed ($W_2\text{g}$). The crude fibre of sample = $W_1 - W_{2(g)}$

$$\% \text{ Crude fibre} = \frac{(W_1 - W_2)100}{5\text{g}}$$

Triplicate values for each sample were obtained.

iv. Ash, crude protein, ether extract (crude fat) and carbohydrates contents determination

The ash content, crude protein and fat in samples were determined according to method described[7]. While total carbohydrates for each powder sample was determined by difference method (subtraction of the sum of the % moisture, % Ash, % Protein, % Crude fat, % crude fibre from 100).

IV. RESULTS AND DISCUSSION

A. Physical and functional properties of imitation egg powder samples

The bulk density, foaming capacity, wettability, water hydration, oil absorption, emulsification and gelation capacities of imitation egg powder (egg substitute powder) samples and control (whole egg powder) are shown in table

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1. The bulk density values for the five experimental imitation egg powder ranged from 0.40 – 0.45g/ml, samples 301 and 201 showing the lowest and greatest values respectively. While sample 601 (control, whole egg powder) is 0.51 g/ml, greater than any of the imitation egg samples but not significantly different ($p \leq 0.05$). Greater bulk density of natural whole egg powder than the imitation egg powder is an indication of bulkier particle which might be due to the egg yolk content which is animal based. Foaming capacity also ranged from 30.0 – 41.0%, samples 401 and 201 with the lowest and highest values respectively, and the control (sample 601) with the value of 40.0% in between the experimental sample values.

This shows that, there is equivalent egg albumin ingredient in the egg substitute (soy protein) since it is the egg white (albumin) that is responsible for the foam formation. This corroborates the fact that soy protein isolate has been shown to be a suitable foaming agent[12]. Wettability ranged from 6.10 -7.17s, including that of the control, which is 6.20s. All the samples showed low wettability values, which indicate good reconstitution property, similar to previous research findings on the physical and chemical properties of food powder[13].

The samples had water absorption capacities ranging from 1.40 -1.80 (ml/g), samples 101, 201 and 601 (control sample) with 1.80, 1.60 and 1.60 ml/g respectively, are not significantly different ($p \leq 0.05$), while others had slightly reduced values, which however did not affect the reconstitution property.

Oil absorption capacities of the sample are found to be similar, which ranged from 2.20-2.60 ml/g. The values represent allowable range for egg powder and related products. The samples had emulsification capacities that ranged from 44.0-44.8%, showing no significant difference ($p \leq 0.05$) among the egg substitutes and whole egg powder (control). Although, 44.8% value for the control was the highest, probably due to the natural egg white present which makes whole egg a good emulsifying agent. Also, gelation capacity values had a range of 5.0-6.5%, showing no significant difference ($p \leq 0.05$) among the samples and even the control. Similarity in gelation property is explained as the result of preponderance protein quality and quantity in the samples.

Table 1: Physical and functional properties of egg substitute powder and control sample (whole egg powder)

Physical/functional properties	Samples					
	101	201	301	401	501	601
Bulk density (g/mL)	0.40 ^a ±0.02	0.45 ^a ±0.01	0.35 ^a ±0.04	0.40 ^a ±0.03	0.40 ^a ±0.03	0.51 ^a ±0.01
Foaming capacity (%)	40.2 ^f ±0.04	41.0 ^f ±0.02	35.0 ^f ±0.05	30.0 ^g ±0.04	32.0 ^g ±0.03	40.0 ^f ±0.02
Wettability (sec).	7.17 ^b ±0.01	6.30 ^b ±0.02	6.50 ^b ±0.02	6.10 ^b ±0.03	6.10 ^b ±0.02	6.20 ^b ±0.04
Water hydration capacity (mL/g)	1.80 ^c ±0.02	1.60 ^c ±0.01	1.40 ^d ±0.02	1.40 ^d ±0.01	1.45 ^d ±0.01	1.60 ^c ±0.02
Oil absorption capacity (mL/g).	2.60 ^e ±0.02	2.20 ^e ±0.01	2.20 ^e ±0.02	2.25 ^e ±0.01	2.20 ^e ±0.03	2.60 ^e ±0.03
Emulsification capacity (%)	44.0 ^h ±0.01	44.5 ^h ±0.02	44.0 ^h ±0.3	44.0 ^h ±0.02	44.5 ^h ±0.01	44.8 ^h ±0.02
Gelation capacity (%)	6.0 ⁱ ±0.10	5.5 ⁱ ±0.02	5.0 ^j ±0.01	5.0 ^j ±0.01	5.5 ⁱ ±0.02	6.5 ⁱ ±0.01

Reconstitution ratio: 3mL water/g powder.

Values represent mean of 3 determinations ±SEM

Means in a row with the same superscript letter are not significantly different ($P \leq 0.05$)

SEM – Standard error of the mean

Sample codes:

- Sample: 101 – Contains cowpea (1 part), soy (1 part)
- 201 – Contains cowpea (2 parts), soy (1 part)
- 301 – Contains cowpea (1 part), soy (2 parts)
- 401 – Contains cowpea (3 parts), soy (2 parts)
- 501 – Contains cowpea (2 parts), soy (3 parts)
- 601 – Whole egg powder (as control)

B. Organoleptic/sensory properties of egg substitute and whole egg powder samples

Table 2 shows the mean sensory scores of reconstituted fried egg substitute powder and whole egg powder (as control). The mean colour scores ranged from 4.64 -5.92; samples 101, 201, and 601 (control) with similar ratings of 5.92, 5.71 and 5.46 respectively. While 301, 401 and 501 samples were also similar in colour ratings and found significantly different ($p \leq 0.05$) from the previous other samples probably due to caramelization reaction of sugar in the ingredient rather than normal maillard reaction that resulted into attractive brownish – yellow colour. Samples 101,

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201, 301, 501 and 601 (control) had similar flavour scores ranging from 5.41-6.04 and sample 401 with mean score of 4.95 which is significantly different ($p \leq 0.05$) from others, indicating the absence of egg flavour, dominated by cowpea flavour. The texture rating for the samples were similar; ranging from 5.33-5.71, except sample 501 with lower rating of 4.88. This might be attributable to very high proportion of soy flour in the sample, that could contribute toughness. The taste scores for samples 101, 201, 301, 501 and 601 (control) were similar and ranged from 5.20-5.78, while sample 401 with mean taste score of 4.98 was slightly different. Apparently both flavour and taste followed the same trend among the samples. The mouthfeel scores for all the samples, including the control were similar and ranged from 5.10-5.64, showing no significant difference ($p \leq 0.05$) among the egg substitute powder samples.

Table 2: Mean sensory scores of reconstituted fried egg substitute powder and control

Sensory attribute	Sample					
	101	201	301	401	501	601
Colour	5.92 ^a ±0.74	5.71 ^a ±1.20	4.85 ^b ±0.94	4.64 ^b ±0.74	4.92 ^b ±0.82	5.46 ^a ±1.10
Flavour	5.64 ^e ±0.74	5.41 ^c ±1.05	5.54 ^c ±0.86	4.95 ^d ±0.77	5.48 ^c ±0.90	6.04 ^c ±0.63
Texture	5.64 ^f ±0.49	5.40 ^f ±1.01	5.37 ^f ±1.44	5.33 ^f ±1.10	4.88 ^g ±1.05	5.71 ^f ±0.82
Taste	5.78 ^h ±0.84	5.55 ^h ±0.84	5.48 ^h ±1.25	4.98 ^h ±1.03	5.20 ⁱ ±0.95	5.57 ^h ±0.64
Mouth Feel	5.22 ^k ±0.52	5.03 ^k ±0.33	5.52 ^k ±0.65	5.45 ^k ±0.51	5.10 ^k ±0.83	5.64 ^k ±0.60

Values represent average of 10 scores ±SEM (standard error of the mean)

Means in a row with the same superscript are not significantly different ($p \leq 0.05$)

Sample codes:

- Sample: 101 – Contains cowpea (1 part), soy (1 part)
- 201 – Contains cowpea (2 parts), soy (1 part)
- 301 – Contains cowpea (1 part), soy (2 parts)
- 401 – Contains cowpea (3 parts), soy (2 parts)
- 501 – Contains cowpea (2 parts), soy (3 parts)
- 601 – Whole egg powder (as control)

C. Nutrients contents of egg substitute powder products and whole egg powder

Shown in Table 3 are the values of the moisture content, crude protein, Ash, crude fibre, fat, carbohydrates and beta carotene contents of the formulated egg substitute samples and whole egg powder.

Moisture content (dry basis) ranged from 6.65 -6.8%, showing similarity and no significant difference ($p \leq 0.05$) detected. The values are low enough with corresponding low water activity to guarantee safe keeping with extended shelf life, when packaged in moisture and gas proof container. Crude protein contents of samples ranged from 31.72 -43.15%, samples 201 and 501 with the lowest and highest values respectively. Both 401 and 501 samples have higher protein contents than whole egg powder (control sample) due to high proportion of cowpea and soy flour. Ash contents (as mineral elements) ranged from 2.25% (in sample 201) to 4.15% (in sample 401), control sample with 4.03%, and only sample 201 was significantly different in protein content due to its ingredient components. Again, all the experimental samples had crude fibre content, ranging from 0.61 – 1.50% due to the presence of fibrous ingredients and little or no fibre in whole egg powder (0.01%). However, the presence of small quantity of fibre in egg substitute would contribute some nutritional benefits. Crude fat ranged from 12.01% (sample 101) to 16.40% (sample 401) in experimental egg substitute samples and 10.94% in sample 601 (control) which is slightly lower, but did not constitute any significant difference. Higher fat contents might be contributed by melon ingredient, which could not constitute any source of cholesterol in imitation egg product.

Total carbohydrates contents ranged from 35.3% (sample 301) to 38.52% (sample 101) and sample 601, (control) with 38.09%. No significant difference ($p \leq 0.05$) detected. Beta carotene contents were found to range from 163.5 mg/100g (control sample 601) to 193.1 mg/100g (sample 301). All the experimental samples had higher beta carotene than the control (whole egg powder), which is nutritionally advantageous.

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Table 3: Proximate and nutrients composition of egg substitute powder and whole egg powder (control sample)

Analytical parameter	Samples					
	101	201	301	401	501	601
Moisture, db(%)	6.70 ^a ±0.03	6.71 ^a ±0.01	6.80 ^a ±0.05	6.70 ^a ±0.02	6.65 ^a ±0.9	6.70 ^a ±0.03
Crude protein(%)	38.48 ^b ±0.35	31.72 ^c ±0.26	40.53 ^b ±0.27	42.15 ^b ±0.18	43.15 ^b ±0.21	40.21 ^b ±0.19
Ash (%)	3.50 ^d ±0.10	2.25 ^e ±0.15	3.85 ^d ±0.10	4.15 ^d ±0.20	3.98 ^d ±0.14	4.03 ^d ±0.13
Crude fibre (%)	1.50 ^t ±0.2	1.41 ^t ±0.01	0.61 ^g ±0.05	0.98 ^g ±0.02	0.85 ^g ±0.01	0.01 ^h ±0.01
Ether extract (as crude fat) (%)	12.01 ⁱ ±0.11	14.50 ⁱ ±0.13	13.11 ⁱ ±0.10	16.40 ⁱ ±0.11	12.87 ⁱ ±0.18	10.94 ⁱ ±0.20
Carbohydrates (%)	38.52 ^j ±0.21	37.28 ^j ±0.19	35.30 ^j ±0.22	36.4 ^j ±0.15	37.27 ^j ±0.18	38.09 ^j ±0.20
Beta carotene (mg/100g)	192.3 ^k ±1.02	190.1 ^k ±1.25	193.1 ^k ±0.97	191.2 ^k ±1.04	186.6 ^k ±0.95	163.5 ^k ±1.06

Values represent average of 3 determinations ± SEM

Means in a row with the same superscript are not significantly different ($p \leq 0.05$)

Sample codes:

- Sample: 101 – Contains cowpea (1 part), soy (1 part)
 201 – Contains cowpea (2 parts), soy (1 part)
 301 – Contains cowpea (1 part), soy (2 parts)
 401 – Contains cowpea (3 parts), soy (2 parts)
 501 – Contains cowpea (2 parts), soy (3 parts)
 601 – Whole egg powder (as control)

V. CONCLUSION

Five coded imitation egg (egg substitute) powder samples were produced (as 101, 201, 301, 401, 501) and whole egg powder provided (sample 601). The functional, sensory properties and nutrient composition were determined. It was found that samples 101 containing cowpea (1 part), soy flour (1 part) and 201, containing cowpea (2), soy flour (1) shared similar properties of bulk density, foaming, hydration, oil absorption, emulsification, gelation capacities and wettability with the whole egg powder (control). Colour, flavour, texture and taste sensory attributes were also similar to reconstituted fried whole egg powder. However, sample 101 was higher in crude fibre, fat, beta carotene and carbohydrates contents than sample 601 (whole egg powder as control). While samples 301, 401 and 501 were higher in crude protein and beta carotene contents than sample 601 (control), but were less preferred in terms of colour and flavour sensory attributes. By and large, sample 101 shared the most similar functional, sensory and nutrient content properties with whole egg powder (sample 601) and shown to be the most appropriate egg substitute that resembled whole egg powder and thus, equally suitable as potential industrial ingredient for various food applications.

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