EFFECT OF EXTRUSION ON PROTEIN QUALITY, ANTI-NUTRITIONAL FACTORS AND DIGESTIBILITY OF COMPLEMENTARY DIET FROM QUALITY PROTEIN MAIZE AND SOYBEAN PROTEIN CONCENTRATE

BY

OMOSEBI M.O., OSUNDAHUNSI O.F. AND FAGBEMI T.N.

INTERNATIONAL CONFERENCE (HUMBOLDT-KOLLEG)

FEDERAL UNIVERSITY OF TECHNOLOGY AKURE

APRIL 2017

INTRODUCTION

Many children in developing countries survive on a nutritionally inadequate diet (Nestel *et al.,* 2003).

Children become stunted not only as a result of insufficient calorie intakes, but also because of poor quality diets (Victora *et al.*, 2012)

Complementary foods being introduced should augment micro and macro nutrient intake (Yeung, 1998).

In developing countries like Nigeria, complementary foods are mainly based on starch tubers like cocoyam, sweet potato or on cereals like maize, millet and sorghum.

Children are normally given these staples in the form of gruels that is either mixed with boiled water or boiled with water (Igyor *et al*., 2011).

Zarkadas *et al*. (2000) observed that QPM genotypes contained high levels of lysine and trytophan compared to normal maize.

Soybean Protein Concentrate (SPC) is 65-67% crude protein. The extraction process removes the anti-nutritional factors (ANF's) in regular soybean meal (USSEC, 2008).

Food with balanced amino acid profile can be obtained by mixing legumes and cereal grains.

The retention of these essential nutrients would be enhanced through the application of extrusion cooking processes (Iwe, 2003).

The anti nutritional factors present in legumes are reduced to the barest minimum in the protein concentrates (Endres, 2001).

OBJECTIVES

Assess the nutritional quality of the diet using the *in-vitro* digestibility

Assess the effect of extrusion cooking on the nutritional quality of the formulated meal


MATERIALS
AND
METHODS

MATERIALS

Consumer friendly varieties of Cassava roots (TMS 4(2) 1425) was purchased from International Institute for Tropical Agriculture (IITA), Ibadan

Soybeans (TGx1987-10F) was purchased from International Institute for Tropical Agriculture (IITA)

Quality protein maize (ART/98/SUWN/SR) was purchased from Institute of Agricultural Research and Technology (IAR&T), Ibadan

The product was extruded in the Crop Utilization unit, IITA Ibadan

The cassava starch was processed using the method described by Osundahunsi *et al.,* (2011) as shown in Fig. 1

- The protein concentrate was processed using the method described by (Adebowale *et al*., 2003) as shown in Fig. 2.

The quality protein maize was cleaned and milled to give a fine meal.

- The maize meal, cassava starch and soybean protein concentrates were mixed in proportions to reach the target protein content of at least 18% using regression analysis (Altan et al., 2009).

The moisture content of the mixture was adjusted, extruded, cooled, milled and packaged for analysis.

Cassava roots

↓

Peeling

↓

Washing

↓

Grating

↓

Mixing with water

↓

Filteration

↓

Settling

↓

Starch Washing

↓

Settling and dewatering

↓

Drying (35±2°C)

↓

Milling

↓

Native Cassava starch

Fig 1. Production of Cassava Starch (Osundahunsi *et al.*, 2011)

Full-Fat Soy Flour

↓

Defatting

↓

Defatted Soy Flour

↓

Alkaline solubilization
(flour:water (1:10) at pH 8.0-8.5. stir for 4-5 hours)

↓

Centrifugation → Sediment
(at 5000rpm for 10 mins)

↓

Acid precipitation
(adjust supernatant to pH 4.0 with 0.1M HCl)

↓

Centrifugation → Supernatant
(at 5000rpm for 7 mins)

↓

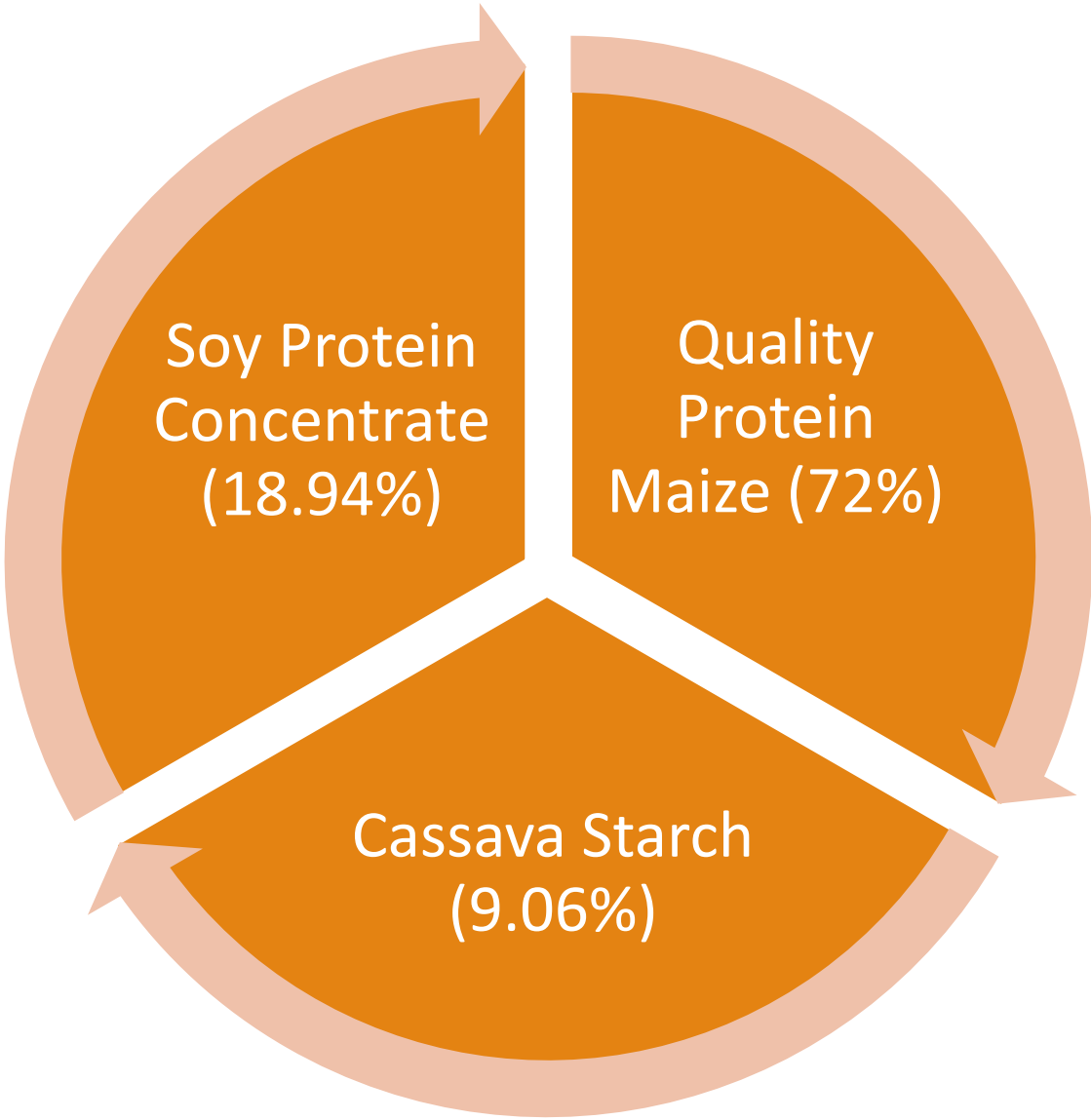
Freeze Drying

↓

Soy Protein Concentrate

Fig 2--- Production of Soybean Protein Concentrate (Adebowale et al., 2003

COMPOSITION OF THE MEAL



EXTRUDER

Table 1: Extrusion conditions

Product	Extrusion Temperature (°C)	Feed moisture content (%)	Screw Speed (rpm)
A	180	20	230
B	170	20	200
C	180	18	200
D	-	-	-

D: Unextruded meal

❖Amino acid content/ profile was determined using the method of Bidlingmeyer et al., (1984)

❖ The Anti-nutritional factors (trypsin inhibitor, phytic acid, tannins, and cyanide) were determined (Kakade *et al*., (1974); Wheeler and Ferrel (1971); Joslyn, (1970); Padmaja, (1989); Poonam *et al*., (1984); Bokanga, (2001).

In-vitro Digestibility

In-vitro protein digestibility (IVPD) was evaluated using the multienzyme method(3.1mg chymotrypsin, 1.6mg trypsin, 1.3mg peptidase /ml) method described by Gupta and Singh (2005).

In-vitro starch digestibility was carried out using the method described by Singh *et al*., (1982). The IVSD was calculated from the constructed maltose standard curve.

Table 2. Amino acid composition (g/100g protein), essential amino acid (EAA) score, total EAA (TEAA)

Amino Acid	A		B		C		D		Requirement (infant under 2 yrs)
	g/100g protein	EAA Score	g/100g protein	EAA Score	g/100g protein	EAA Score	g/100g protein	EAA Score	
Lysine	5.427	104.4	5.360	103.1	5.301	101.9	5.275	101.4	5.2
Histidine	3.088	118.8	3.205	123.3	3.267	125.7	3.160	121.5	2.6
Threonine	3.441	78.2	3.509	79.8	3.514	79.9	3.406	77.4	4.4
Cysteine	1.888		1.744		1.440		1.640		
Methionine	1.591	120.0	1.374	107.5	1.775	110.9	1.407	105.1	2.9
Valine	4.599	115.0	4.315	108.6	4.450	111.25	4.334	108.35	4.0
Isoleucine	3.992	114.1	3.661	104.6	3.685	105.3	3.837	109.6	3.5
Leucine	8.751	109.4	8.777	109.7	9.197	115.0	8.715	108.9	8.0
Tyrosine	3.196	133.7	3.164	132.1	3.226	133.11	3.164	134.1	6.3
Phenylalanine	5.225		5.157		5.160		5.283		
Tryptophan	0.960	87.3	0.974	88.5	0.876	79.6	0.945	85.9	0.74
Total	42.16		41.24		41.89		41.17		37.64

Table 3. Limiting amino acid (LAA) of extruded and uncooked samples and Non Essential amino acids (g/100g)

Amino acid	A	B	C	D
Limiting amino acids	Threonine & Tryptophan	Threonine & Tryptophan	Threonine & Tryptophan	Threonine & Tryptophan
Non Essential amino acids				
Arginine	7.061	7.008	6.958	7.109
Aspartic acid	10.695	10.821	10.160	10.890
Serine	5.470	5.705	5.624	5.646
Glutamic acid	19.967	20.587	20.103	20.827
Proline	7.753	8.052	8.415	7.990
Glycine	3.869	3.920	3.867	3.889
Alanine	4.674	4.837	5.142	4.597

A: ($T_{180}{}^{o}C$, $MC_{20\%}$, SS_{230rpm}); B: ($T_{170}{}^{o}C$, $MC_{20\%}$, SS_{200rpm}); C: ($T_{180}{}^{o}C$, $MC_{18\%}$, SS_{200rpm}); D: (uncooked meal)

Table 4. Nutritional quality of the extruded and unextruded meals of QPM, soybean concentrate and cassava starch.

	A	B	C	D
TEAA/TAA%	41.5	40.4	41.0	40.3
TNEAA/TAA%	58.5	59.6	59.0	59.7
TSAA(Meth+Cys)	3.479	3.118	3.215	3.047
ArEAA(Phe + Tyr)	8.421	8.321	8.386	8.447
TEAA/TNEAA	0.71	0.68	0.69	0.68
EAAI (%)	98.07	95.94	96.06	95.66
BV (%)	95.20	92.87	93.01	92.57

A: ($T_{180}{}^{o}{}_{C}$, $MC_{20\%}$, SS_{230rpm}); B: ($T_{170}{}^{o}{}_{C}$, $MC_{20\%}$, SS_{200rpm}); C: ($T_{180}{}^{o}{}_{C}$, $MC_{18\%}$, SS_{200rpm}); D: (unextruded meal)
Total essential amino acids (TEAA). Total amino acids (TAA), Total non-essential amino acids (TNEAA), Total sulphur amino acids (TSAA), Aromatic essential amino acids (ArEAA), Protein efficiency ratio (PER), Essential amino acid index (EAAI), Biological value (BV).

Table 5: Anti nutritional Factors

Sample ID	Trypsin inhibitor (mg/g sample)	% Phytic acid	Tannin (mg/g)	Cyanide (mg/100g)
A	1.76±0.02	0.83±0	0.04±0.01	0.11±0.02
B	1.80±0.01	0.83±0.04	0.03±0	0.13±0.02
C	2.08±0.01	0.84±0.01	0.04±0.01	0.11±0.01
D	8.32±0.02	1.01±0.02	0.05±0	0.20±0.01

A: (T_{180^oC}, $MC_{20\%}$, SS_{230rpm}); B: (T_{170^oC}, $MC_{20\%}$, SS_{200rpm}); C: (T_{180^oC}, $MC_{18\%}$, SS_{200rpm}); D: (uncooked meal)

Table 6: In vitro Starch Digestibility

Sample ID	IVSD (mg maltose/g sample)	IVSD (%)
A	602.52	60.25[a]±0.03
B	598.54	59.85[a]±0.01
C	601.93	60.19[a]±0.01
D	402.40	40.24[b]±0.02

A: ($T_{180}{}^{o}C$, $MC_{20\%}$, SS_{230rpm}); B: ($T_{170}{}^{o}C$, $MC_{20\%}$, SS_{200rpm}); C: ($T_{180}{}^{o}C$, $MC_{18\%}$, SS_{200rpm}); D: (uncooked meal)

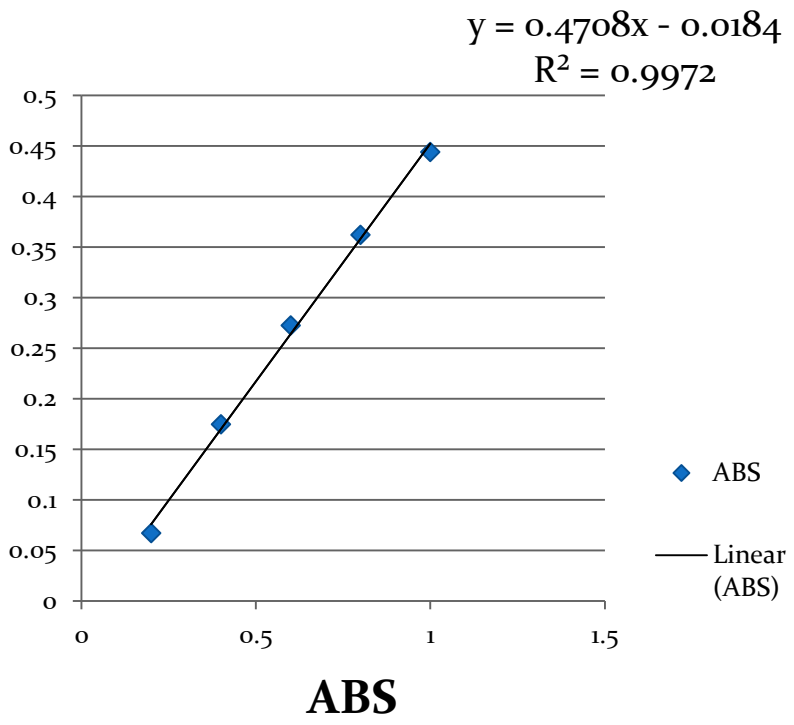


Fig 6: Maltose standard curve

Table 7: In vitro Protein Digestibility

Sample ID	IVPD (%)
A	$92.98^{a}\pm0.05$
B	$90.44^{b}\pm0.02$
C	$89.90^{b}\pm0.01$
D	$84.80^{c}\pm0.02$

A: ($T_{180}{}^{o}C$, $MC_{20\%}$, SS_{230rpm}); B: ($T_{170}{}^{o}C$, $MC_{20\%}$, SS_{200rpm}); C: ($T_{180}{}^{o}C$, $MC_{18\%}$, SS_{200rpm}); D: (uncooked meal)

CONCLUSION

- Extrusion cooking improved the protein and starch digestibilities of the samples.
- Extrusion significantly reduced the anti-nutritional factors.
- Extrusion cooking had no significant effect on the amino acid content of the products.

THANK YOU