DEVELOPMENT OF INDUSTRIALLY PROCESSED COMPLEMENTARY FOODS FROM LOCALLY AVAILABLE INGREDIENTS

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Content

1. Background

- In most developing countries including Ethiopia the prevalence of under nutrition and micronutrient deficiencies is high among infants and young children aged 6 to 23 months.

- The growth of infants and young children's in their first two years of life is very rapid and breast feeding only will not be sufficient for the infant nutritional requirement.

- Therefore, appropriate infant feeding (including breast-feeding and complementary feeding practices) are fundamental to children's nutrition, health, and survival during this period.

- Complementary feeding means giving other foods in addition to breast milk.

- The aim is to introduce smoothly a soft digestible diet containing adequate calories, proteins and other micronutrients (especially iron, zinc, calcium and vitamin A), free of contamination (pathogens, toxins or harmful chemicals).

- In Ethiopia, traditional or commercial complementary foods are usually produced from staple cereals and legumes prepared either individually or as composite gruels.

- Cereal grains are considered to be one of the most important sources of dietary proteins, carbohydrates, vitamins and minerals for people in developing countries.

- However, the nutritional quality of cereals and sensorial properties of their products are sometimes inferior or poor.

- Therefore, the aims of the present study are to develop a complementary food with good nutritional composition and sensory attributes as compared with both traditional or commercial complementary foods .

2. Objective

- **General Objective**
  - To develop nutritious and acceptable complementary foods using staple foods and food based proteins, vitamins, minerals and energy at different proportions to enhance the nutritional profile of the product.

- **Specific objectives**
  - To assess the nutritional and anti-nutritional profile of the raw material.
  - To assess the effect of blending on the overall quality of the developed products.
  - To assess the effect of raw material treatment on the reduction of anti-nutritional content.

3. Materials and Methods

3.1 Raw material selection

➢ Based on their nutritional composition and accessibility the ff ingredients were selected and collected from the central market of Addis Ababa.

No	Raw Materials	Major source of	Minor source of
1	Carrot	Vitamin A, CHO	K, Na, protein, Vitamin C etc
2	Wheat Flour	CHO, Protein	Ash
3	Milk powder	Ca, Zn, Fat , Protein and calories	Fe, Mg, vitamin A
4	Soybean	Protein , Fe, and calories	Fat, Ca
5	Lentil	Fe, Protein and calories	Fat, Zn, cu etc
6	Chickpea	Protein, Fe and Zn	Fat, Ash etc.
7	Shortening	Fat	Vitamins and minerals
8	Sugar	CHO, sweetener	
9	Baking powder		
10	Salt		

3.2 Raw material preparation

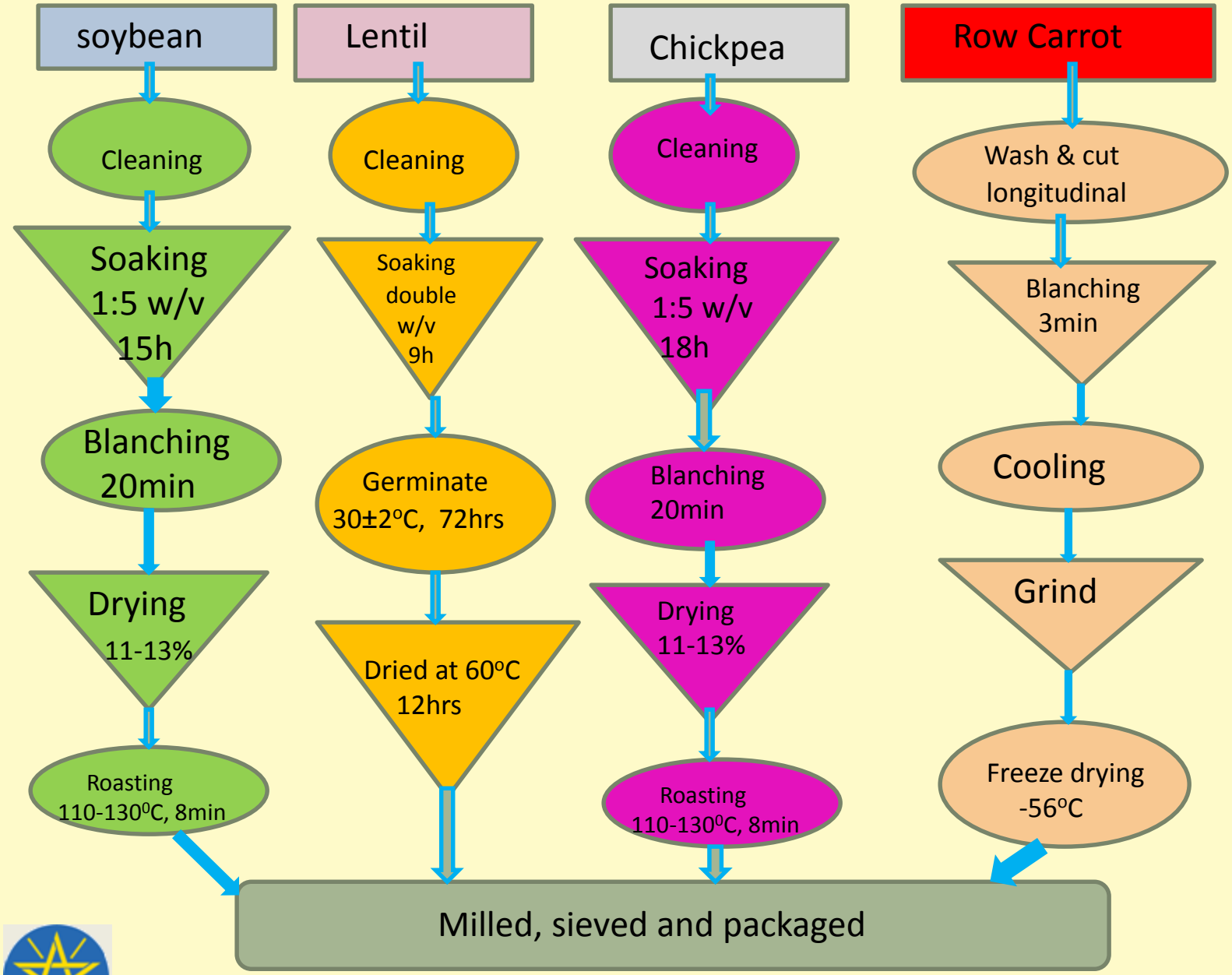

Figure 1: Raw material preparation

3.3 Nutrient composition analysis for (R+P)

- Proximate analysis
  - based on AOAC methods (moisture, protein, fat, fiber and ash)
- Analysis of anti nutritional factors
  - Phytate content was determined according to the method described by Latta and Eskin (1980).
  - Tannin was determined by Burns, 1971 method as modified by (Maxson and Rooney, 1972).

3.4 Product formulation

Was accomplished through the application of NutriSurey2007 software.

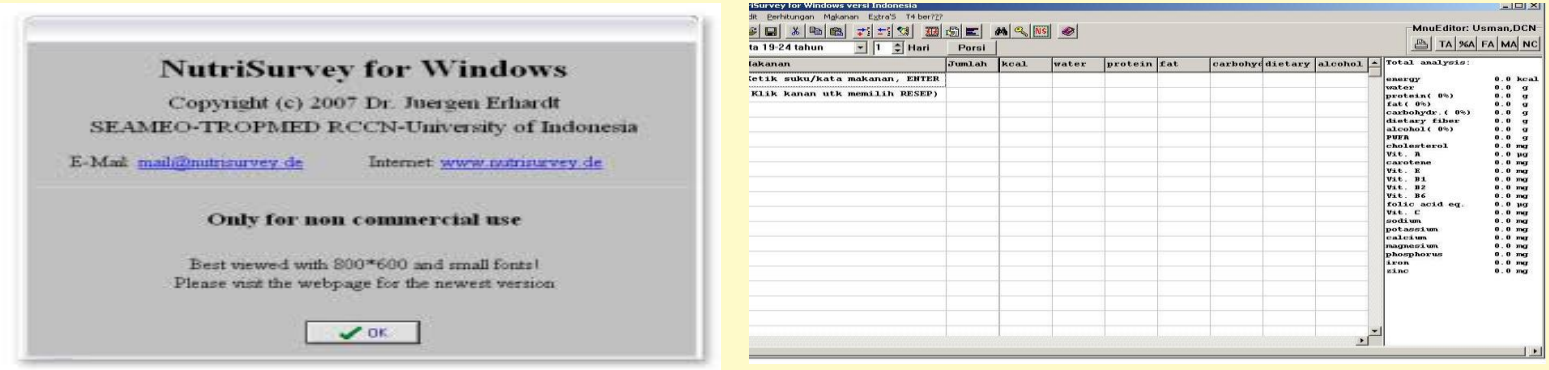

Figure 2: Application of NutriSurvey 2007

Composition of ingredients	Product 1	Product 2	Product 3	Product 4	Product 5	Product 6	Product 7	Product 8
Carrot (g/100g)	X	X	X	X	X	X	X	X
Wheat Flour (g)	X	X	X	X	X	X	X	X
Sugar	X	X	X	X	X	X	X	X
salt	X	X	X	X	X	X	X	X
Shortening	X	X	X	X	X	X	X	X
Baking powder	X	X	X	X	X	X	X	X
Chickpea (g/100g)	X	X	-	X	X	X	-	X
Soybean (g/100)	X	-	X	X	X	-	X	X
Lentil (g/100g)	-	X	X	X	-	X	X	X
Milk powder (g/100)	-	-	-	-	X	X	X	X

Table 2 : food formulation table

3.5 Complementary food production and infant feeding

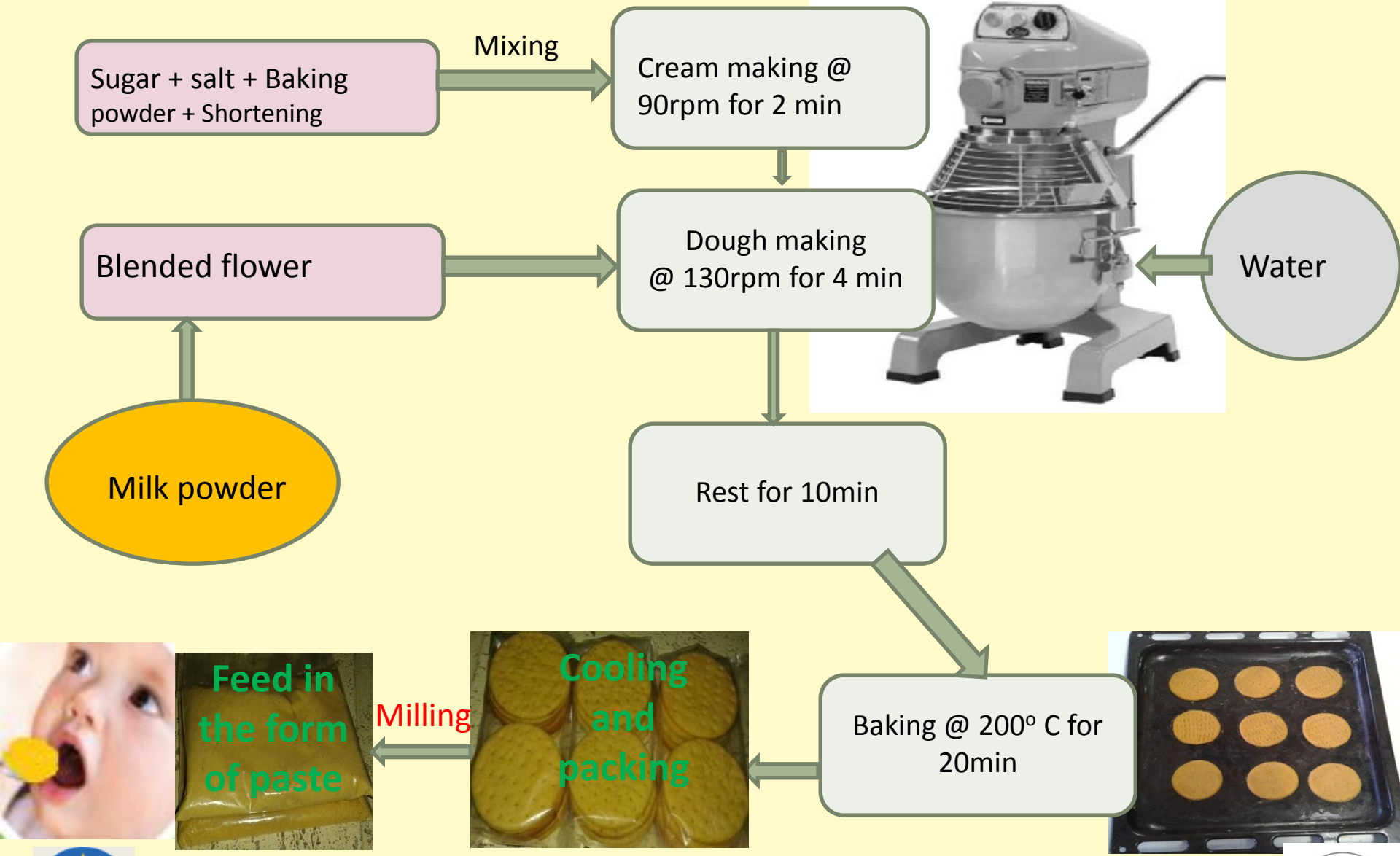

Figure 3: The main process of product development

3.6 Experimental design and data analysis

- Experimental design

  Completely randomized design (CRD)

- Statistical data analysis

  was accomplished by using ANOVA in SPSS Version 20

3.7 Sensory analysis

was employed 9 point hedonic scale

3.8 Product selection method

The best product was selected based on the rank of each products associated with WHO recommendation.

4. Result and Discussion

4.1 Nutritional Composition of raw Material

No.	Raw material name	Moisture	Protein	Fat	Fiber	Carbohydrate	Fe (mg/100g)	Zn (mg/100g)	Ca (g/100g)	Vitamin A µgRE/100gm
1	Carrot	6.4	5.4	0.1	5.5	73.3	4.8	1.5	1.9	2825.5
2	Wheat Flour	10.7	11.9	1.8	3.2	74.2	3.0	1.7	1.8	BDL
3	Milk powder	4.1	24.2	25.0	0.1	40.0	11.1	4.67	1.0	BDL
4	Soybean	5.4	46.3	11.8	4.4	26.5	8.38	2.36	2.0	BDL
5	Lentils	9.4	24.8	1.2	5.8	58.3	15.1	2.6	2.8	BDL
6	Chickpeas	6.6	21.8	7.8	1.8	60.0	5.3	2.7	2.0	BDL

Table 1 : Nutritional Composition of raw Material

4.2 Proximate Composition of the new products

- The crude protein content of Product 1 and Product 4 are no significantly different b/n each other but their is a mean d/c b/w other products at ($p<0.05$) and slightly lower than from the control product.
- The crude fat content of Product 3 is higher than and significantly different from other products including the control product at ($p<0.05$) . All formulations except the control product are aligned with FAO/WHO recommendation.
- The total energy of Product 3 is higher than the others and their is no significant d/c with Product 4, whereas all products except the control product are a good source of energy as the recommendation of FAO/WHO.

Nutrients	Product 1	Product 2	Product 3	Product 4	Control	FAO/WHO (g/100 g)
Moisture	6.68 ± 0.04^{a}	4.08 ± 0.14^{b}	5.00 ± 0.0^{c}	3.54 ± 0.10^{d}	4.56 ± 0.03^{e}	< 5
Total Ash	1.54 ± 0.61^{a}	1.40 ± 0.30^{a}	1.66 ± 0.33^{a}	2.28 ± 0.03^{ab}	3.034 ± 0.13^{b}	<3
Crude protein	11.97 ± 0.10^{a}	9.80 ± 0.11^{b}	11.68 ± 0.04^{c}	12.02 ± 0.03^{a}	13.52 ± 0.06^{d}	>15
Crude fat	14.22 ± 0.06^{a}	12.72 ± 0.45^{b}	15.38 ± 0.08^{c}	14.68 ± 0.15^{a}	0.63 ± 0.15^{d}	10-25
Crude fiber	0.85 ± 0.03^{a}	0.63 ± 0.17^{a}	0.55 ± 0.09^{a}	0.73 ± 0.04^{a}	1.25 ± 0.08^{b}	< 5
Carbohydrate	64.05 ± 1.01^{a}	70.60 ± 0.8^{b}	64.62 ± 0.68^{a}	65.20 ± 0.22^{a}	75.23 ± 0.10^{c}	64
Energy (kcal/100g)	432.35 ± 4.97^{a}	436.39 ± 0.43^{ab}	443.90 ± 3.29^{c}	441.3 ± 0.57^{bc}	360.64 ± 1.95^{d}	400-425

Table 5: Proximate Composition (g/100g Dry weight matter) of complementary food without milk powder

- The crude protein content of Product 5, 7 and 8 are no significantly different b/n each other but their is a mean d/c b/w other products at ($p<0.05$) and Product 5 is slightly lower than the control product.

- The crude fat content of Product 5 and 8 are no significant different b/n each other but their is a mean d/c b/w other product at ($p<0.05$) and product 5 is slightly higher than from the other products.

- The total energy of product 8 is higher than the others and significantly different from other products at ($p<0.05$) , whereas all other products except the control product meet FAO/WHO recommendation.

Nutrients	Product 5	Product 6	product 7	Product 8	Control	FAO/WHO (g/100 g)
Moisture	6.89 ± 0.18^{a}	8.07 ± 0.09^{b}	7.06 ± 0.00^{a}	6.51 ± 0.02^{c}	4.56 ± 0.03^{d}	**< 5**
Total Ash	3.00 ± 0.45^{a}	2.70 ± 0.28^{a}	2.14 ± 0.17^{b}	2.08 ± 0.01^{b}	3.034 ± 0.14^{a}	**<3**
Crude protein	12.57 ± 0.17^{a}	11.30 ± 0.27^{b}	12.84 ± 0.19^{a}	12.46 ± 0.18^{a}	13.52 ± 0.06^{c}	**>15**
Crude fat	14.14 ± 0.01^{a}	12.45 ± 0.52^{b}	11.64 ± 0.35^{b}	13.75 ± 0.15^{a}	0.63 ± 0.15^{c}	**10-25**
Crude fiber	0.48 ± 0.1^{a}	20.60 ± 0.44^{a}	0.97 ± 0.04^{b}	3.05 ± 0.08^{c}	1.25 ± 0.08^{b}	**< 5**
Carbohydrate	60.39 ± 0.86^{a}	62.78 ± 0.32^{b}	64.18 ± 0.50^{c}	63.12 ± 0.13^{bc}	75.23 ± 0.10^{d}	**64**
Energy (kcal/100g)	419.43 ± 2.88^{a}	408.60 ± 4.44^{b}	413.08 ± 0.41^{b}	426.38 ± 1.51^{c}	360.64 ± 1.95^{d}	**400-425**

Table 6: Proximate Composition (g/100g Dry weight matter) of complementary food with milk powder

4.3 Micronutrient Composition of the new products

- **The Vitamin A content of all four products are attain and above the FAO/WHO recommendation but the control product was below detection level, all products are significantly different each other** at ($p<0.05$) .
- **The Iron content of Product 3 is higher than the other products but still it does not meet FAO/WHO recommendation but it is successfully higher than the control product.**
- **The Zinc content of Product 1, 2 and 3 are not significantly different but lower than the FAO/WHO recommendation and a promising progress when compared with the control product.**
- **The Calcium content of the control product is higher than the other formulated products significantly.**

Nutrients	Product 1	Product 2	Product 3	Product 4	Control	FAO/WHO
Vit. A µgRE/100kcal	20.0 ± 0.3^{a}	43.3 ± 1.0^{b}	26.7 ± 0.1^{c}	34.7 ± 0.2^{d}	BDL^{e}	**9**
Fe	2.2 ± 0.5^{a}	1.9 ± 0.4^{a}	6.9 ± 0.9^{b}	5.4 ± 0.1^{b}	2.5 ± 0.2^{a}	**8**
Zn	0.7 ± 0.2^{a}	0.6 ± 0.2^{a}	0.7 ± 0.2^{a}	0.5 ± 0.0^{b}	0.25 ± 0.0^{b}	**3.2**
Ca	143.32 ± 64.2^{a}	106.74 ± 21.7^{a}	146.9 ± 26.2^{a}	78.60 ± 22.4^{a}	326.40 ± 63.1^{b}	**500**
P	186.04 ± 3.4^{a}	152.34 ± 23.8^{b}	207.33 ± 7.1^{ac}	148.09 ± 16.8^{b}	231.49 ± 6.7^{c}	**456**

Table 7: Micronutrient Composition (g/100g Dry weight matter) of complementary food without milk powder

- **The Vitamin A content of the milk based products are still attain the FAO/WHO recommendation but the control product has below detection level, except diet 6 and the control product the other diets are significantly similar to each other at ($p<0.05$) .**

- **The Iron content of Product 5 is higher than all other products but still it does not meet FAO/WHO recommendation but successfully higher than the control product.**
- **The Zinc content of Product 5, 6, 7 and 8 are not significantly different but lower than the FAO/WHO recommendation but they are higher Zn concentration when compared with the control product.**

- **The Calcium content of all milk based diets are progressively changed when compared with non-milk based diets but still a significant gap with FAO/WHO recommendation.**

Nutrients	Product 5	Product 6	product 7	Product 8	Control	FAO/WHO
Vit. A µgRE/100kcal	11.7±0.0^{a}	12.3±0.6^{b}	18.6±0.2^{a}	13.6±0.2^{a}	BDL^{c}	9
Fe	6.4±0.7^{a}	4.4±0.9^{b}	5.9±0.0^{a}	5.6±2.0^{a}	2.5±0.2^{c}	8
Zn	0.7±0.2^{a}	0.6±0.1^{a}	0.7±0.1^{a}	0.6±0.1^{a}	0.25±0.0^{b}	3.2
Ca	355.06±50.3^{a}	294.19±19.6^{b}	313.58±4.4^{b}	295.03±64.9^{b}	326.40±63.1^{b}	500
P	191.3±24.2^{a}	97.70±0.1^{b}	81.08±3.7^{b}	176.71±16.4^{a}	231.49±6.7^{c}	456

Table 8: Micronutrient Composition (g/100g Dry weight matter) of complementary food with milk powder

4.4 The Sensory attributes of the new products

Product	Color	Test	Aroma	Texture	Over all acceptance
Product 1	8.10±0.9[a]	7.80±1.3[a]	7.50±1.5[a]	7.70±1.1[a]	7.80±1.2[a]
Product 2	8.30±1.0[a]	7.10±1.8[a]	7.30±2.0[a]	7.00±1.3[a]	7.20±1.2[a]
Product 3	8.00±0.9[a]	6.80±1.9[a]	6.90±2.0[a]	7.00±1.5[a]	7.60±1.1[a]
Product 4	8.20±0.8[a]	7.40±1.2[a]	7.40±1.8[a]	6.90±1.4[a]	7.50±1.1[a]
Control	7.70±1.0[a]	7.10±2.2[a]	7.10±1.9[a]	7.50±1.4[a]	6.60±1.9[a]

Table 9: The sensory attributes of complementary food without milk powder

Product	Color	Test	Aroma	Texture	Over all acceptance
Product 5	8.80±0.42a	8.90±0.32a	8.60±1.27a	8.50±1.08a	8.70±0.68a
Product 6	8.70±0.48a	8.70±0.68a	7.90±1.60a	8.50±0.97a	8.80±0.42a
Product 7	8.50±0.71a	8.30±0.68a	8.70±0.68a	8.60±0.51a	8.70±0.48a
Product 8	8.60±0.52a	8.40±0.97a	8.20±0.92a	8.10±1.10a	8.10±0.74a
Control	7.40±1.17b	8.10±0.81a	7.90±0.88a	7.40±1.71b	7.70±1.16a

Table 10: The sensory attributes of complementary food with milk powder

Product	Water absorption capacity gm/100gm	Oil absorption capacity gm/100gm
Product 1	104.00±0.16[a]	85.61±0.32[a]
Product 2	98.79±0.68[b]	77.76±0.72[b]
Product 3	101.89±0.89[a]	81.99±0.25[c]
Product 4	125.05±1.31[c]	78.74±1.07[b]
Control	471.76±0.66[d]	175.47±0.50[d]

Table 11: The water and oil absorption capacity of complementary food without milk powder

Product	Water absorption capacity gm/100gm	Oil absorption capacity gm/100gm
Product 5	111.79±0.39[a]	90.49±0.40
Product 6	114.85±0.67[b]	94.53±0.51
Product 7	110.57±0.17[a]	94.73±0.28
Product 8	123.56±0.47[c]	97.97±0.43
Control	471.76±0.66[d]	175.47±0.50

Table 12: The water and oil absorption capacity of complementary food with milk powder

Nutrients	Product 1	Product 2	Product 3	Product 4	Control
Moisture	5	2	4	1	3
Ash	2	1	3	4	5
Protien	3	5	4	2	1
Fat	3	4	1	2	5
Fiber	4	2	1	3	5
CHO	1	4	2	3	5
Energy	1	2	4	3	5
Overall acceptance	1	4	2	3	5
Water absorption capacity	3	1	2	4	5
Iron	4	5	1	2	3
Zinc	1	3	2	4	5
Vit. A	1	4	2	3	5
Total	29	37	28	34	52
Rank	2	4	1	3	5

Table 13: Ranking of formulated complementary foods without milk powder to determine optimal nutritional profile.

Nutrients	Product 5	Product 6	product 7	Product 8	Control
Moisture	3	5	4	2	1
Ash	4	3	2	1	5
Protein	3	5	2	4	1
Fat	1	3	4	2	5
Fiber	1	5	2	4	3
CHO	4	3	1	2	5
Energy	2	4	3	1	5
Overallacceptance	2	1	2	4	5
Water absorbition capacity	2	3	1	4	5
Iron	1	4	2	3	5
Zinc	1	3	1	3	5
Vit. A	3	2	4	1	5
Calcium	1	5	3	4	2
Total	28	46	31	35	52
Rank	1	4	2	3	5

Table 16: Ranking of formulated complementary foods with milk powder to determine optimal nutritional profile.

5. Conclusion

- The study investigated the proximate composition, sensory attributes and anti-nutritional analysis of eight formulated complementary foods from the combinations of locally available ingredients.

- Product 3 and 5 were ranked best when compared with other formulated Products (table 13 and 14).

- However, all eight newly formulated Products were good sources of high quality energy and micronutrient composition as a complementary food.

- Nutritionally, the formulated products were better than the control product (a commercial complementary food) in terms of proximate composition.

- Finally it is advisable to feed the new products for children as complementary food.

6. Phase two activities

- Further Product characterization as an industrial product will be carried out .
- Study on the shelf life stability
- Zn and Fe bioavailability study will be conducted.
- Cost analysis is the other feature under this phase
- Making of Industrial linkage for large scale production

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