

# Fortification of cassava with vitamin A through the use of orange-fleshed sweetpotato (OFSP) during product development and the estimated profit margin

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# Introduction

- Cassava is among the major food security crops in Sub-saharan Africa (Leyva-Guerrero, Narayanan, Ihemere, and Sayre, 2012).
- Cassava is **the fourth most important source of carbohydrate** in the tropics after rice, maize, and sugar cane and it is a staple food for more than **500 million people** due to its high starch content (As reviewed by Blagbrough, Bayoumi, Rowan, and Beeching, 2010).
- A typical adult-sized cassava meal (500 g dry mass) would provide sufficient calories (≈1800) but it **may not provide adequate** amounts of iron, zinc, **vitamin A**, and protein (Leyva-Guerrero et al., 2012).

# Introduction

- This implies that cassava would be the right crop for fortification with vitamin A given its importance in the diet of different communities in Africa.
- Vitamin A deficiency (VAD) is a public health problem in developing countries (Samba et al, 2006; Bovell-Benjamin, 2007)

# Materials and Methods

# Fortification of cassava

The fortification of cassava was achieved by combining different proportions of OFSP and cassava products:

- **Cassava flour:** Ugali
- **Chikwangu:** DRC, the Republic of Congo; **Cassava products similar to *Chikwangu* are produced** in Central African Republic, Sudan, Gabon, and Angola.



**Products made based on cassava flour with OFSP  
supplementation**

# Table 1: OFSP-Cassava flour

Product	Ingredient	Quantity (g)	Mixing time (min.)	Frying time (min.)	Heat level*	Number of products	Shape of the products
Bwiza: <i>Beauty</i>	OFSP puree	225.0	2	12	3	10	Spherical
	Wheat flour	30.0					
	Cassava flour	112.5					
	Baking Soda	2.5					
	Sugar	30.0					
	Salt	1.5					
	Water	120 ml					
	Vanilla Sugar	8.0					
	Oil	500 ml					
Icyanga: <i>Taste</i>	OFSP puree	270.0	2	14	3	9	Spherical
	Wheat flour	30.0					
	Cassava flour	112.5					
	Baking Soda	2.5					
	Sugar	30.0					
	Salt	1.5					
	Water	100 ml					
	Vanilla Sugar	8.0					
	Oil	500 ml					
Subira: <i>Try again</i>	S.P puree	300.0	2	12	3	9	Spherical
	Onion	35.0					
	Cassava flour	112.5					
	Baking Soda	2.5					
	Garlic	7.0					
	Salt	1.0					
	Water	80 ml					
	Cube maggi	1.0					
	Oil	500 ml					
	Eggs	1.0					

# Table 1: OFSP-Cassava flour

Product	Ingredient	Quantity (g)	Mixing time (min.)	Frying time (min.)	Heat level*	Number of products	Shape of the products
Ubuzima: <i>Life</i>	S.P puree	320.0	2	12	3	9	Spherical
	Onion	35.0					
	Wheat flour	30.0					
	Cassava flour	112.5					
	Baking Soda	2.5					
	Garlic	7.0					
	Salt	1.0					
	Water	60 ml					
	Cube maggi	1.0					
	Oil	500 ml					
Urumuri: <i>Light</i>	Raw and grated OFSP	150.0	2	5	2	8	Rectangular
	Onion	35.0					
	Cassava flour	100.0					
	Baking Soda	2.5					
	Garlic	7.0					
	Salt	1.0					
	Water	50 ml					
	Cube maggi	1.0					
	Oil	500 ml					
Nezerwa: <i>Feel happy</i>	Raw and grated OFSP	150.0	2	5	2	9	Rectangular
	Onion	35.0					
	Cassava flour	100.0					
	Baking Soda	2.5					
	Garlic	7.0					
	Salt	1.0					
	Water	60 ml					
	Cube Maggi	1.0					
	Oil	500 ml					



Products made based on chikwangue with OFSP  
supplementation

## Table 2. Chikwangue with OFSP

Products	Ingredients (g)		The form of OFSP used	Processing procedures*
	Pre-cooked cassava	OFSP		
Ituze: <i>Tranquility</i>	350	100	Puree	The OFSP puree was rolled into a cylindrical shape and wrapped with the pre-cooked cassava by maintaining the cylindrical shape (diameter: 5.5 cm, length: 17 cm). It was, then, wrapped into a plastic bag and immersed in boiling water for 1h and 30 min. The cooked product was allowed to cool down and then cut into small pieces with a circular shape (diameter: 5.5 cm, thickness: 1-1.5cm).
Ururabo: <i>Flower</i>	350	100	Puree	The pre-cooked cassava was manually mixed with OFSP puree. The mixture was rolled into a cylindrical shape (diameter: 5.5 cm, length: 17 cm), wrapped into a plastic bag and immersed in boiling water for 1h and 30 min. The cooked product was allowed to cool down and then cut into small pieces with a circular shape (diameter: 5.5 cm, thickness: 1-1.5cm).
Icyizere: <i>Hope</i>	350	50	Raw and grated	The pre-cooked cassava was manually mixed with raw grated OFSP. The mixture was rolled into a cylindrical shape (diameter: 5.5 cm, length: 17 cm), wrapped into a plastic bag and immersed in boiling water for 1h and 30 min. The cooked product was allowed to cool down and then cut into small pieces with a circular shape (diameter: 5.5 cm, thickness: 1-1.5cm).
Igisubizo: <i>Solution</i>	350	100	Raw and diced	The raw OFSP was cut into small dices (0.5 cm x 0.5 cm x 0.5 cm) and mixed with pre-cooked cassava, then rolled into a cylindrical shape (diameter: 5.5 cm, length: 17 cm). It was wrapped into a plastic bag and immersed in boiling water for 1h and 30 min. The cooked product was allowed to cool down and then cut into small pieces with a circular shape (diameter: 5.5 cm, thickness: 1-1.5cm).
Gikundiro: <i>Dearly loved</i>	350	100	Raw and grated	The raw grated OFSP was rolled into a cylindrical shape and wrapped with the pre-cooked cassava by maintaining the cylindrical shape (diameter: 5.5 cm, length: 17 cm). It was, then, wrapped into a plastic bag and immersed in boiling water for 1h and 30 min. The cooked product was allowed to cool down and then cut into small pieces with a circular shape (diameter: 5.5 cm, thickness: 1-1.5cm).

## Table 2. Chikwangue with OFSP

Products	Ingredients (g)		The form of OFSP used	Processing procedures
	Pre-cooked cassava	OFSP		
Ishimwe: <i>Award</i>	350	100	Puree	The small pieces (diameter: 5.5 cm, thickness: 1-1.5cm) from product H were fried in oil until the outer layer became crispy with a golden brown colour.
Byiza: <i>Nice</i>	350	100	Puree	The small pieces (diameter: 5.5 cm, thickness: 1-1.5cm) from product I were fried in oil until the outer layer became crispy with a golden brown colour.
Izihirwe: <i>Enjoy</i>	350	50	Raw and grated	The small pieces (diameter: 5.5 cm, thickness: 1-1.5cm) from product J were fried in oil until the outer layer became crispy with a golden brown colour.
Ingoboka: <i>Relief</i>	350	100	Raw and diced	The small pieces (diameter: 5.5 cm, thickness: 1-1.5cm) from product K were fried in oil until the outer layer became crispy with a golden brown colour.
Akizewe: <i>Trustworthy</i>	350	100	Raw and grated	The small pieces (diameter: 5.5 cm, thickness: 1-1.5cm) from product L were fried in oil until the outer layer became crispy with a golden brown colour.

## Sensory evaluation

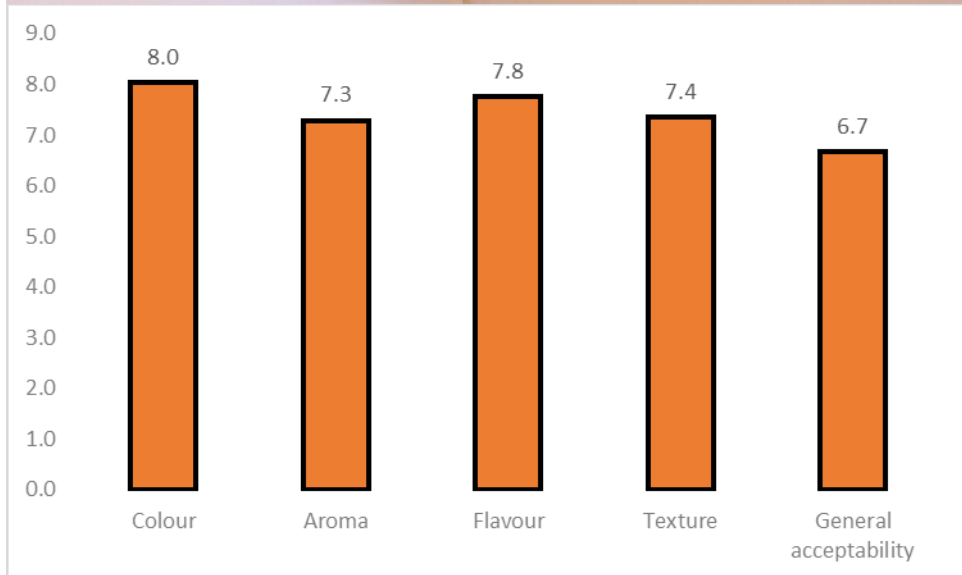
After product formulation, the products cooked and then subjected to a sensory evaluation panel consisting of 53 panellists for products containing OFSP and cassava flour, and 42 panellists for products made from OFSP and cassava (chikwangue) as the main ingredients.

## Estimated Profit Margin

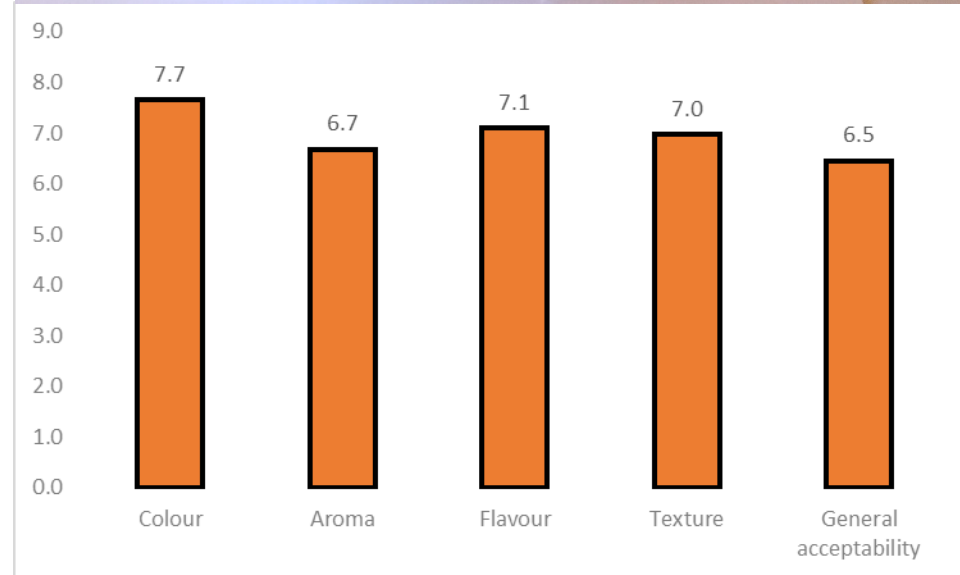
The profit margin was calculated by dividing the estimated net income by sales and expressed as percentage. The net income was determined by subtracting all the expenses (i.e., costs of raw materials, labour and energy) from the total revenue. The profit margin was calculated for these products to enable anyone with the intention of producing them for income generation to guide them in making important business decisions.

# Results

Products made based on cassava flour with  
OFSP supplementation

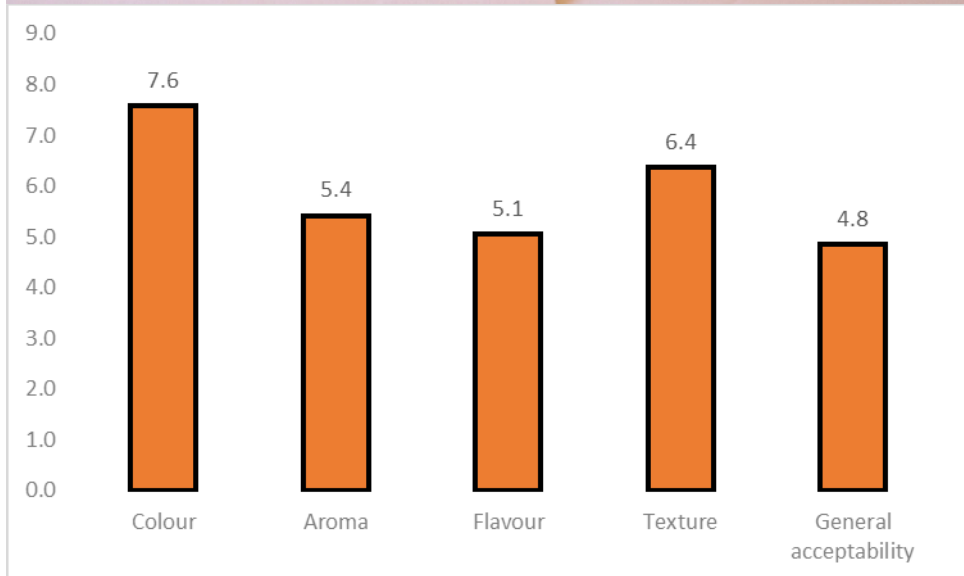


**Fig. Bwiza: *Beauty***

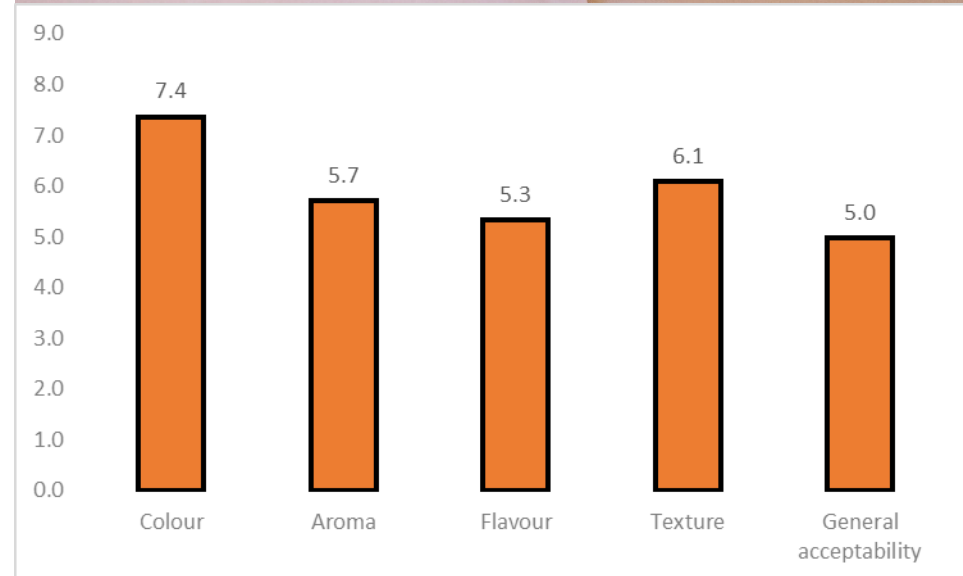


**Fig. Icyanga: *Taste***

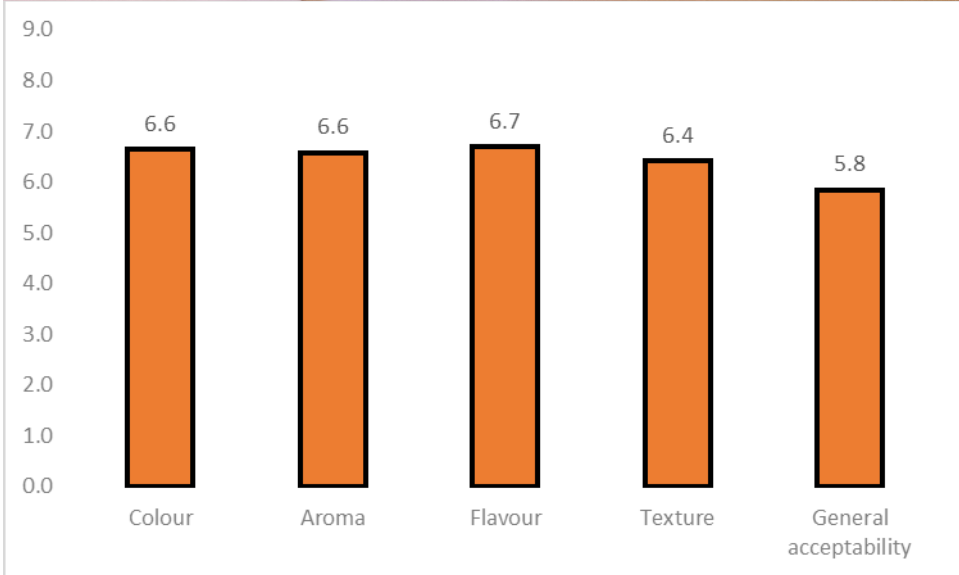




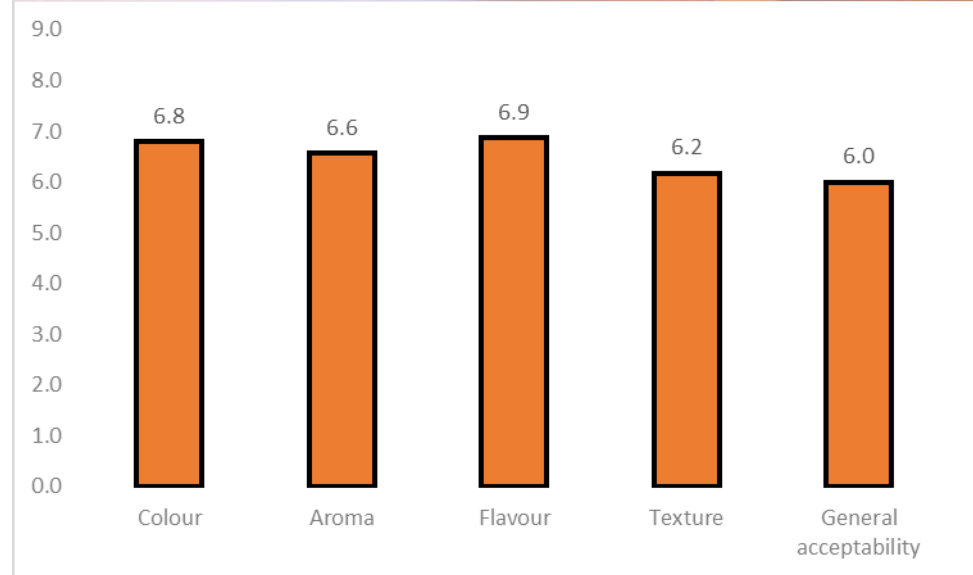
**Fig. Subira: *Try again***



**Fig. Ubuzima: *Life***

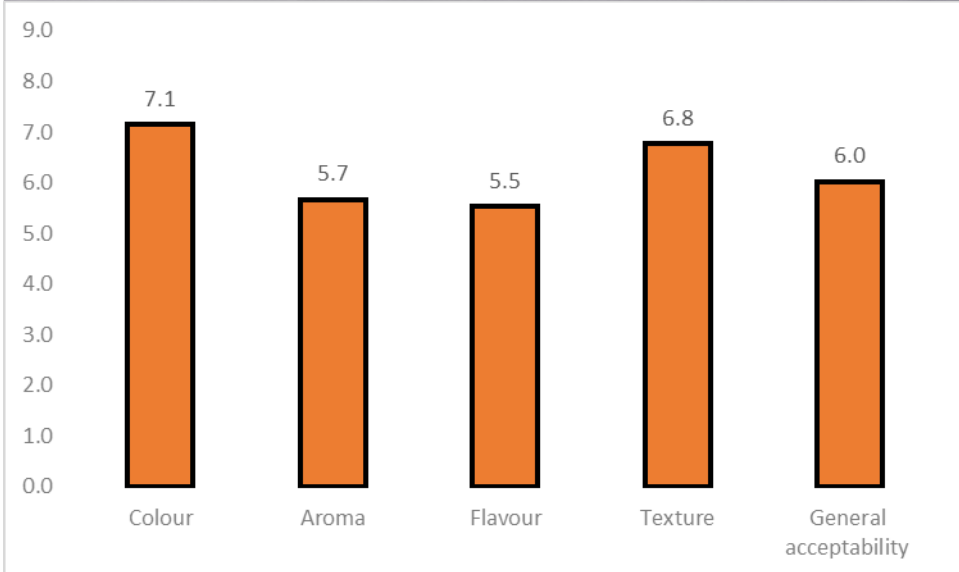


**Fig. Urumuri: *Light***

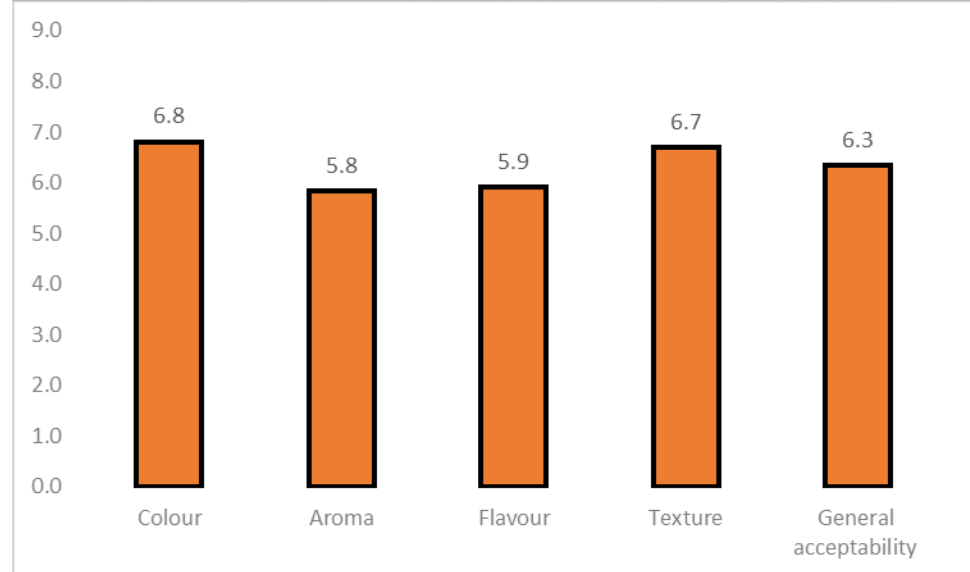


**Fig. Nezerwa: *Feel happy***

Products made based on chikwangue with OFSP  
supplementation

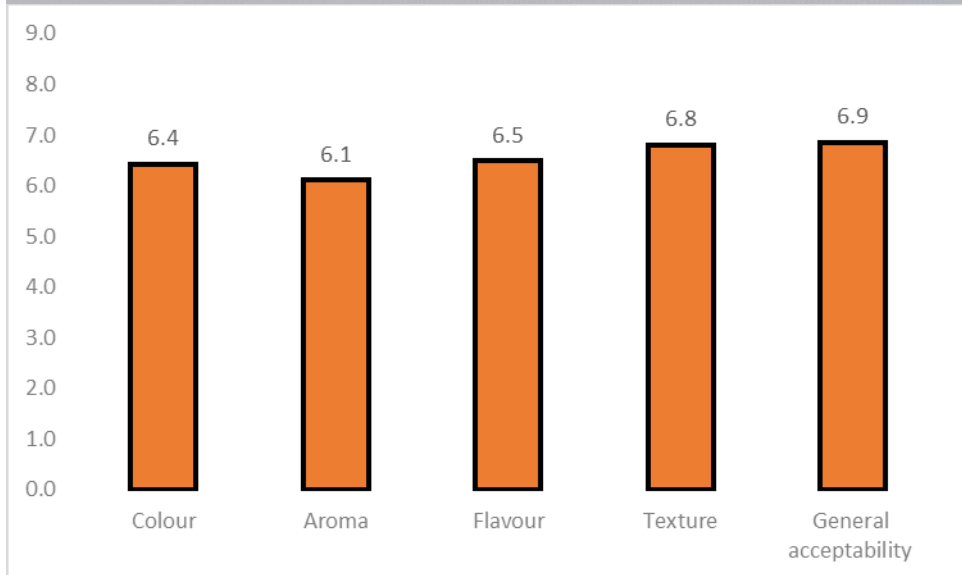


**Fig. Ituze: *Tranquility***

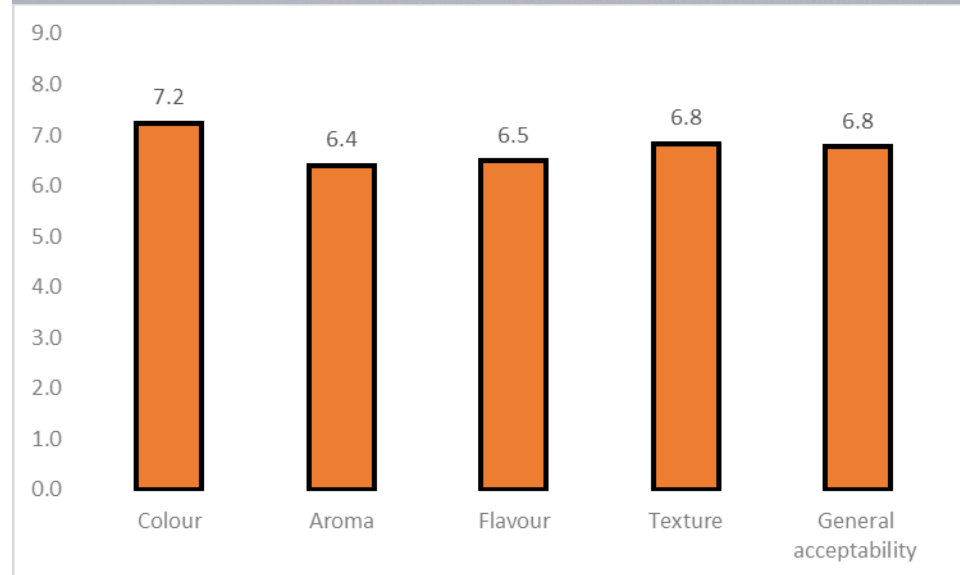


**Fig. Ururabo: *Flower***

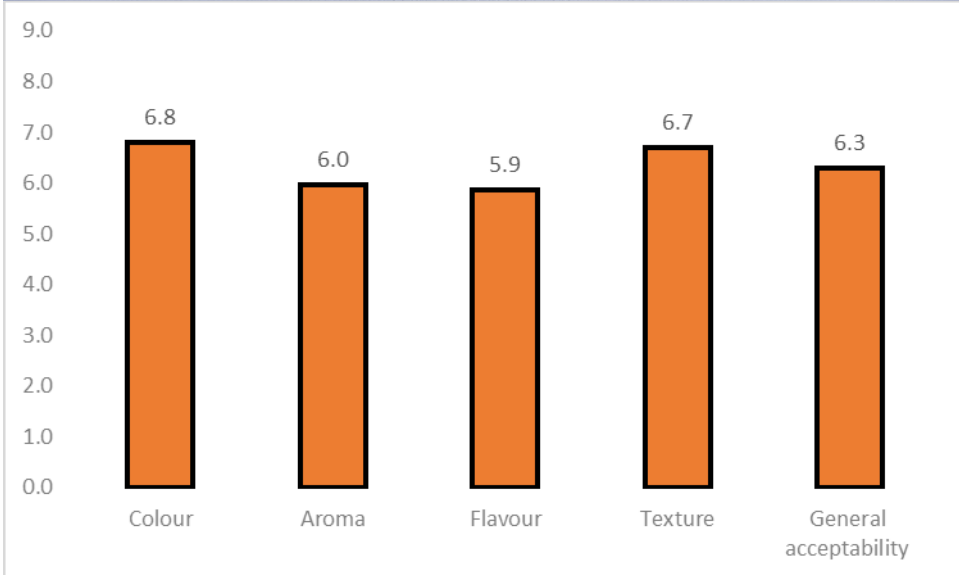




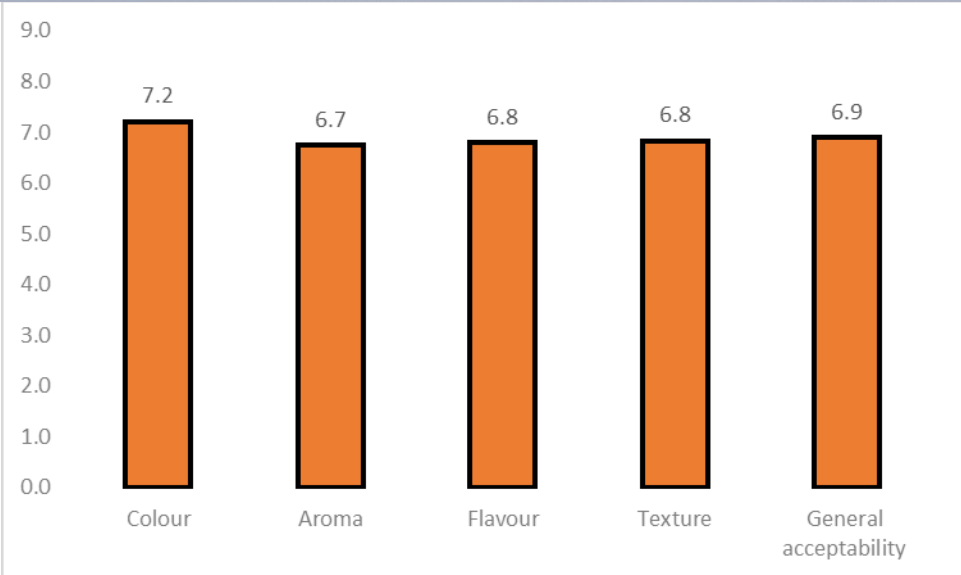
**Fig. Icyizere: *Hope***



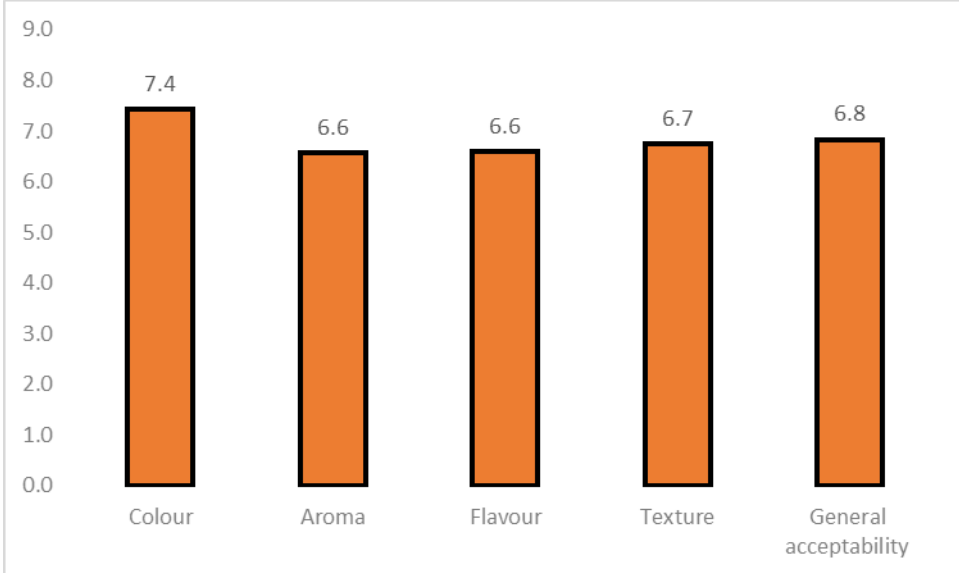
**Fig. Igisubizo: *Solution***



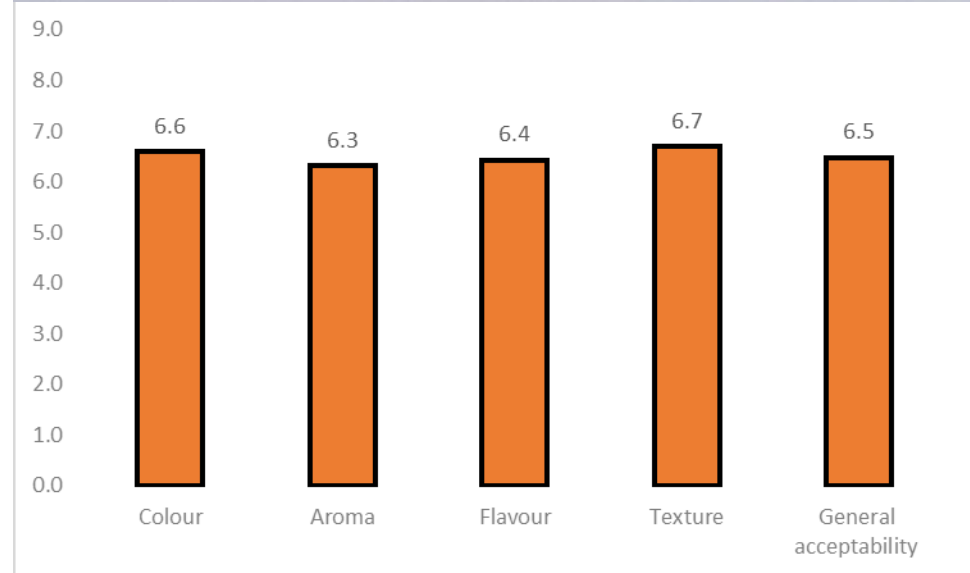
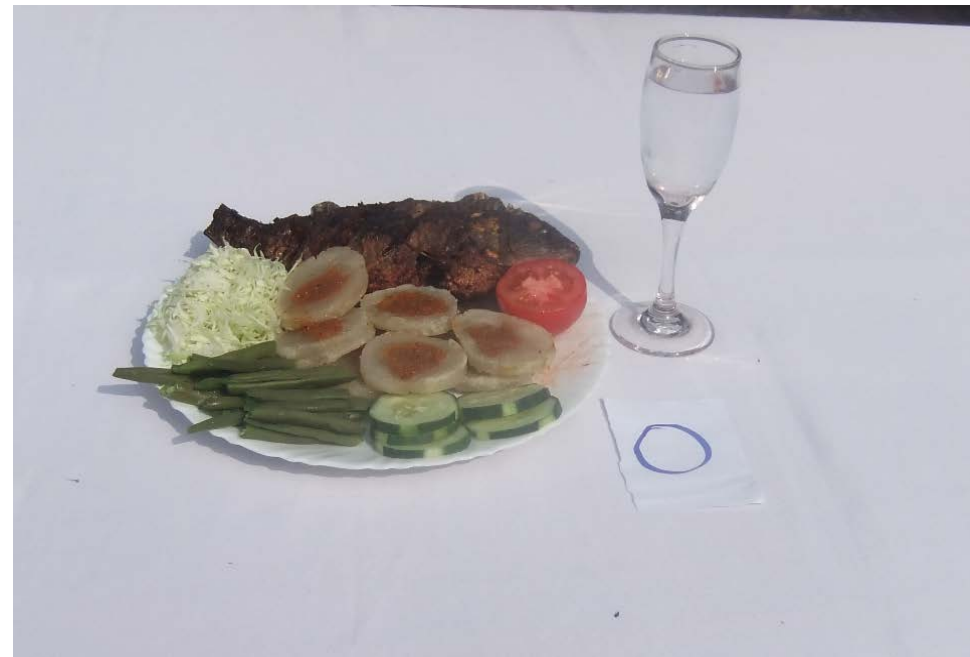
**Fig. Gikundiro: *Dearly loved***



**Fig. Ishimwe: *Award***

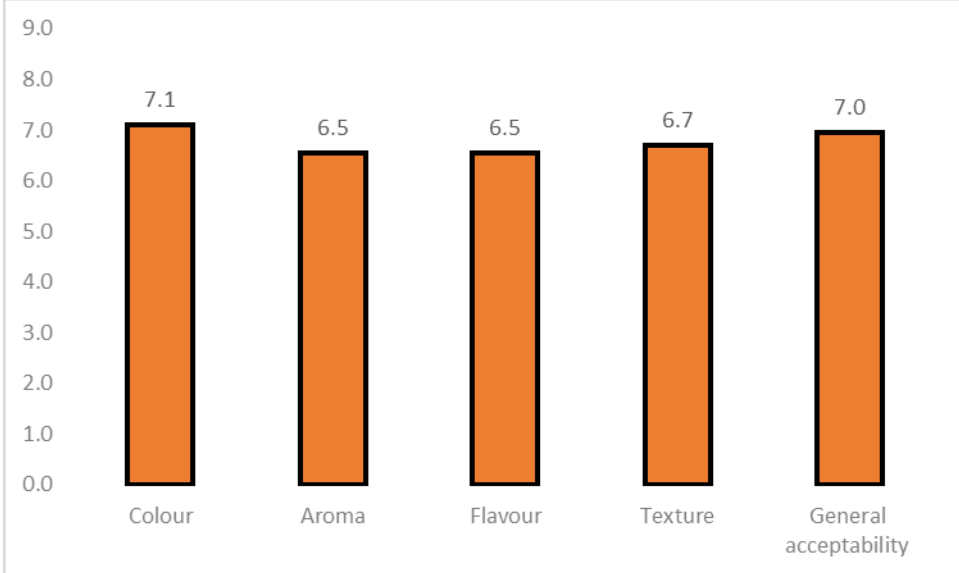


**Fig. Byiza: *Nice***

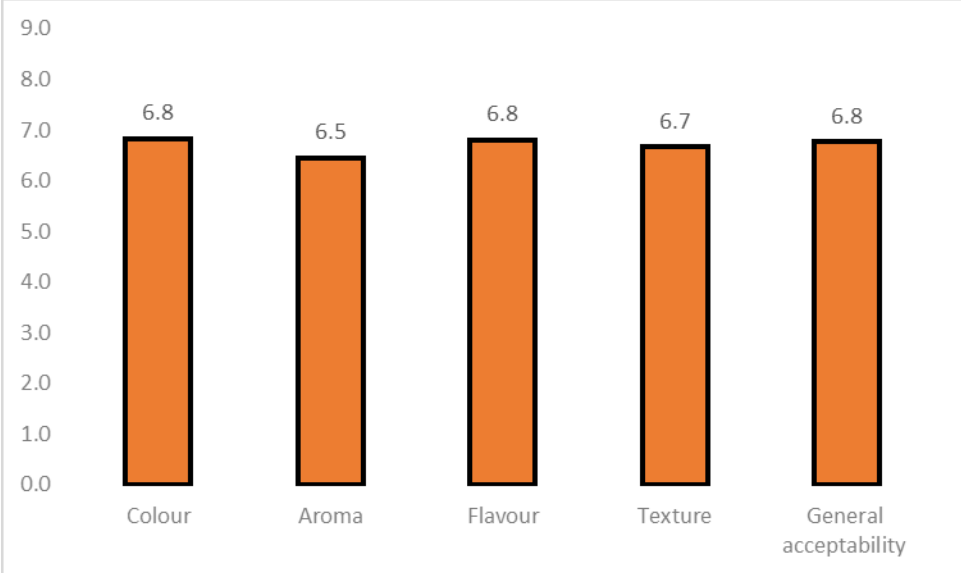
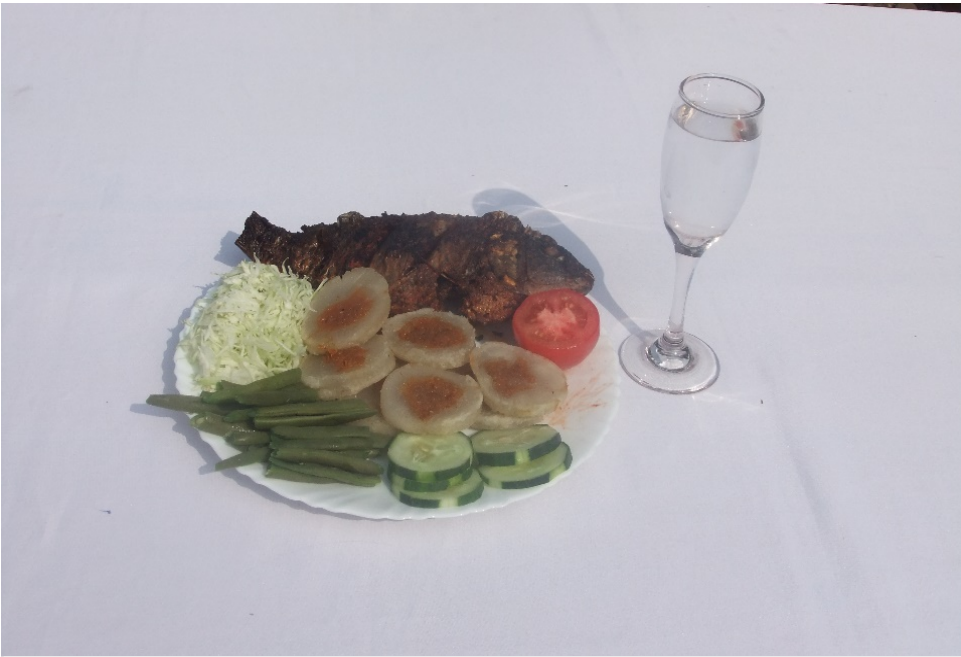


**Fig. Izihirwe: *Enjoy***





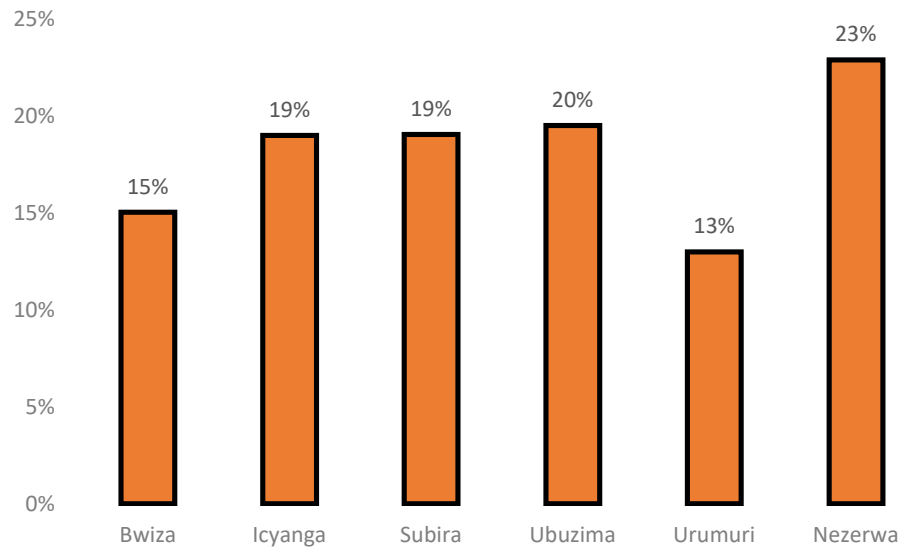
**Fig. Ingoboka: Relief**



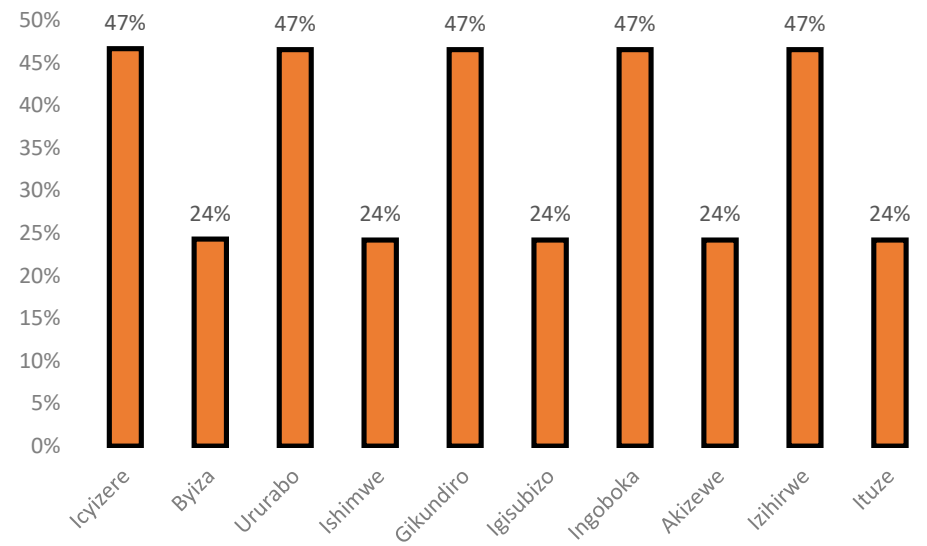
**Fig. Akizewe: *Trustworthy***



# Profit Margin



**Profit margin estimation for products made based on cassava flour with OFSP supplementation**



**Profit margin estimation for products made based on cassava flour with OFSP supplementation**

# Conclusion

- Sixteen new products containing various forms of OFSP and cassava were developed.
- All the products were subjected to sensory analysis and were found to be acceptable by the consumers
- They could therefore be used as tools for combating vitamin A deficiency in sub-Saharan Africa and other developing countries

## Acknowledgement

- We acknowledge the International Potato Centre (CIP) for providing the financial support to conduct this work.
- We extend our gratitude to the Rwanda Agriculture and Animal Resources Development Board (RAB) for allowing its staff to work and use its premises and equipments for developing these products.
- We also thank farmers and other individuals who participated in the sensory evaluation of the new products from OFSP and cassava as they played an important role in validating them.