

# RHEOLOGICAL AND SENSORY ASSESSMENT OF SOYMILK- BASED CHOCOLATE DRINKS AS INFLUENCED BY SUGAR, COCOA POWDER AND FORTIFICANTS

## Abstract :

This research was carried out to evaluate the effect of triple fortification on the rheological and sensory attributes of soymilk-based chocolate drink. Soybean (*Glycine max*) was bought from Benue Agriculture and Rural Development Agency (BNARDA), and cocoa powder was bought from a supermarket in Makurdi, Benue State. Pro- vitamin A, iron, iodine fortificants were purchased at Emole Nig Ltd Makurdi Benue State, Nigeria. The power law regression analysis indicates that soymilk-based chocolate drink is pseudo-plastic (0.62- 0.96) with consistency indices of 15.15- 50.0. Power law model for pseudo- plastic fluids require a force (shear stress) before soymilk- based chocolate drink can flow. The fortified samples FSCD ( $5.88 \pm 1.17a$ -  $8.36 \pm 0.76c$ ) and FPSCD ( $7.16 \pm 1.03b$ -  $7.32 \pm 0.86c$ ) had highest score for flavor, color, taste and general acceptability.

**Keywords:** soymilk-based chocolate drink, cocoa powder, iodine fortificants, polyphenols

## INTRODUCTION

Soy milk is a stable off-white emulsion/ suspension water extract of whole soybean (*Glycine max*) containing water soluble proteins, carbohydrates, and soybean oil when properly processed[1]. Soy milk, *kunu-zaki*, zobo, coconut milk, and tigernut milk are some of the local aqueous non-alcoholic drinks in Nigeria. Nevertheless, soymilk's ease of production and adaptability are credited to its versatility as a beverage around the world. This non-alcoholic drink holds its many health advantages to the predominance of polyunsaturated fatty acids as well as low lactose and cholesterol[1]. Rich in phenolic components cocoa powder contains polyphenols (Phytonutrients), commonly referred to as nutraceuticals or phytochemicals, which are used in fortification or supplementation. Rheological and sensory characterization of soymilk-based chocolate drink can be employed for addressing pumping requirements and as baseline data for standardization and regulatory policies for beverages[2]. Soy milk with incorporation of cocoa powder will not only provide the required nutrients but also act a vehicle for micronutrients and for reduction of PEM. This research was carried out to evaluate the effect of triple fortification on the rheological and sensory attributes of soymilk-based chocolate drink.

## MATERIALS AND METHODS

Soybean (*Glycine max*) was bought from Benue Agriculture and Rural Development Agency (BNARDA), and cocoa powder was bought from a supermarket in Makurdi, Benue State. Pro-

vitamin A, iron, iodine fortificants were purchased at Emole Nig Ltd Makurdi Benue State, Nigeria.

### **Preparation of Soymilk Chocolate Drinks**

The soymilk-based chocolate aqueous drink was produced using the method described by Arslan with modifications[3]. Essentially, soybean was sorted and cleaned to remove stones and damaged, deformed seeds. Then the dry soybean was washed and soaked in water overnight (500g in 1 Litre) for 12 hours. It was then rinsed and blanched in 0.5 % sodium bicarbonate for 30 minutes. The soybean seeds were ground in blender and expressed in the ratio of 3:1 (water to beans on a weight basis) to remove the okra. The obtained milk is then boiled and formulated by adding cocoa powder (0.1, 0.2, 0.3, 0.4 %) and sugar(0, 2, 4, 6 %). The milk was then pasteurized at the temperature 65 °C for 15 seconds and subsequently bottled and refrigerated. The sensory panelists consisted of 25 selected judges made up of students and staff of the Benue State University, Makurdi to pick the most acceptable for flavor, taste, color, mouthfeel and overall acceptability. The sensory attributes were rated on a 9-point hedonic scale (9-like extremely to 1-dislike extremely). The 2 most preferred formulations were treated with triple fortification using 0.15 mg potassium iodide, 2.0 mg ferrous sulphate and 1.6 mg / 100 g sample using standard fortification guide recommended by [4]. Sensory evaluation of most acceptable was performed by descriptive and affective testing with modifications.

### **Rheological Tests: Viscosity Measurements**

The rheological characteristics of soymilk from the formulated products were evaluated as described by [5] with modifications. For each product, a 4 × 6 between and within randomized design comprising 4 shear rates (10, 20, 50, 100 rpm) and 6 temperatures (15, 20, 25, 30, 35 and, 40 °C) which yielded 20 experimental groups was employed. Duplicate determination was carried out using a Brookfield viscometer (model LPDV-II+P) spindle number 61. Duplicate samples of the aqueous drinks were allowed to equilibrate at the desired temperatures in an agitated water bath. Viscometer readings were measured after 2 minutes of spindle rotation. Data obtained from the viscometry was fitted with the power law rheological model as follows:

$$\mu = m\dot{\gamma}^{n-1} \quad (1)$$

Linearization of equation:

$$\mu = \log m + (n-1)\log\dot{\gamma} \quad (2)$$

Where  $\mu$  = viscosity or shear stress of soymilk and cocoa powder-based drink (Ns/m<sup>2</sup>);  $\dot{\gamma}$  = shear rate (rpm);  $m$  = consistency index,  $n$  = flow behaviour index.

## **RESULTS AND DISCUSSION**

### **Effect of Temperature on viscosity of soymilk-based chocolate drink**

The viscosity of soymilk-based chocolate drink as influenced by sugar, fortificants and cocoa powder reduced significantly ( $p < 0.05$ ) with increased shear rate. The plots of viscosity versus shear rate (10,20,50,100 rpm) at varying temperatures (15,20,25,30,35,40 °C) clearly indicates that when temperature increases, the energy level of liquid molecules increases (kinetic energy increases) and the distance between molecules increases. This causes a decrease in inter-molecular attraction hence reduce viscosity.

The power law regression analysis indicates that soymilk-based chocolate drink is pseudo-plastic (0.62- 0.96)with consistency indices of 15.15- 50.0. Power law model for pseudo- plastic fluids require a force (shear stress) before soymilk- based chocolate drink can flow.

## **Sensory Attributes**

### **Effect of Fortification and Sugar on the Sensory Attributes of Soymilk-based Chocolate Drink**

The sensory attributes of 6 % sugar, 0.4 % cocoa powder and 0 % sugar, 0.4 % cocoa powder yielded four (4) samples being fortified 6 % sugar, 0.4 % cocoa powder and nonfortified 6 % sugar, 0.4 % cocoa powder as well as fortified 0 % sugar, 0.4 % cocoa powder and nonfortified 0 % sugar, 0.4 % cocoa powder (Table 1). Sensory qualities of food formulations are an important parameter when testing for acceptability of food products. This is a close representation of preference or reference for target groups. The fortified samples FSCD ( $5.88 \pm 1.17a$ - $8.36 \pm 0.76c$ ) and FPSCD ( $7.16 \pm 1.03b$ - $7.32 \pm 0.86c$ ) had the highest score for flavor, color, taste and general acceptability.

UNDER PEER REVIEW

**Table1: Rheological and Sensory Characteristics of Soymilk-based Chocolate Drink**

Parameter	Sample			
	NPSCD	FPSCD	NSCD	FSCD
<b>Flavor</b>	5.4±1.39a	7.24±1.02b	5.72±1.49a	8.36±0.76c
<b>Taste</b>	4.84±1.8a	7.32±0.86c	5.68±1.8b	7.88±0.93c
<b>Color</b>	5.76±1.17a	7.16±1.03b	5.72±2.06a	5.88±1.17a
<b>Mouthfeel</b>	4.24±1.54a	7.0±0.73c	5.4±1.92b	7.16±0.86c
<b>General</b>				
<b>Acceptability</b>	5.32±1.52a	7.32±0.7b	5.6±2.09a	7.76±0.73b
<b>Shear Rates</b>		<b>At 25□</b>		
<b>10 rpm</b>	15.1	17.6	17.7	18.7
<b>20 rpm</b>	12.8	14.5	14.79	15.7
<b>50 rpm</b>	10.8	13.8	14.21	14.2
<b>100 rpm</b>	9.88	11.1	11.36	13.3
<b>Intercept</b>	3.12	3.27	3.26	3.22
<b>M</b>	22.66	26.20	25.99	25.12
<b>Slope</b>	-0.18	-0.18	-0.17	-0.14
<b>n</b>	0.82	0.82	0.83	0.86
<b>r<sup>2</sup></b>	0.99	0.93	0.91	0.95

## References

1. Iwe, M.O., 2003. The Science and Technology of Soybeans. 20 Communication Service Ltd., Enugu Nigeria
2. World Health Organization. *Malnutrition: factsheet*. 2021 [cited 2021 Oct 22]. Available from: <https://www.who.int/news-room/fact-sheets/detail/malnutrition>.
3. Illinois, E. (2020). Production and Nutritional Benefits of Ultra High blends of Soymilk. *Int. J Food Sc.* 5: 873-879
4. UNICEF (2021). Use of Multiple Micronutrient Powders for Point-of-Use Fortification of Foods Consumed by Infants and Young Children Aged 6–23 Months and Children Aged 2–12 Years; WHO: Geneva, Switzerland
5. Dogan M, Kayacier A (2004). Rheological properties of reconstituted hot salep beverage. *Int. J. Food Prop.* 7:683-691.