UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY (UNCST)

POLICY BRIEF:

Stimulating Production of Shea Butter for Industrial Application in Uganda.

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Executive Summary

The global shea butter market is projected at US$ 2.9Bn by 2025, due to increased demand from cosmetics, pharmaceuticals and confectionary industries. Shea butter a crucial raw material for cooking, cosmetics, and soap production, in Uganda is predominantly produced using artisan and cold pressing methods, which often yield low-quality shea butter, unfit for use. This policy brief outlines findings of a study on establish how quality and industrial applicability of Shea butter produced in Uganda can be enhanced through deployment of advanced technology.

The study deployed dry and solvent techniques to fractionate Shea butter into Olein (liquid) and stearin (solid) fractions at crystallization temperatures (CTs) of 15°C and 20°C. Artisan processed shea butter produced higher olein fraction yields (59.4-59.8%) compared to cold-pressed shea butter (41.5-41.8%) at both CTs. Quality in terms of refractive index, iodine value (IV) and fatty acid (FA) content of the shea fractions were assessed. The refractive index of olein fractions at 15°C (1.465-1.463) was lower than at 20°C (1.467), with no significant quality difference between artisan and cold-pressed samples, while IV of olein fractions I2g/100g (26.26-27.66) was higher than that of stearin fractions (10.01-14.02) at both CTs. FA profile showed higher oleic acid content in olein fractions at both CTs (15°C: 47-59.6%; 20°C: 49.4-51.7%) compared to stearin fractions (31.2-43.7%). Solvent fractionation with acetone at 20°C was most effective, yielding high-quality shea olein suitable for industrial application. The study recommends for adoption of Solvent Fractionation Technology at a crystallization temperature of 20°C for large-scale shea butter production, and that local shea producers should as such be trained in solvent fractionation techniques. A pilot machine was fabricated for fractionation of shea butter for industrial application. Further to this, standards should be developed for high olein shea butter and it diverse benefits in the food and cosmetic industry should be promoted at national and international levels. Further research to optimize fractionation processes and explore additional industrial applications should be conducted as well as collaboration among academia, industry and government. Shea actors should embrace advanced processing methods to boost Uganda's shea butter industry, transform their lives and foster market diversification and economic growth.

Introduction

Shea butter extracted from the nut of the shea tree (Vitellaria paradoxa C.F.Gaertn, family Sapotaceae) is an important raw material for production of cooking oil, margarine, cosmetics and soap (Aculey et al., 2012). The Shea trees exists in the wild in sub-Saharan Africa, extending across 19 countries from Mali in the west to Ethiopia and Uganda in the east (Masters et al,2004). Africa has at least 500 million shea fruiting trees producing about 2.5 million tonnes of dry seed kernel per annum with over 1.2 million tons of shea butter for the world market. Shea butter is highly prized for its therapeutic and cosmetic virtues and for its nutritional potential. Industrially shea butter is used in confectionary and chocolate making as a substitute for cocoa butter (Pages, 2009). Europe's annual consumption of shea butter generally fluctuates between 40,000 - 60,000 tons 95% of which is consumed by the chocolate industry. The quantities exported to Japan, United States or Switzerland are mainly intended for cosmetic or pharmacological use (Badini et al., 2011). Unfortunately, shea butter production is majorly by artisan method practiced by women in local communities (Marlene Elias & Carney, 2007) and cold pressing method by small scale processors, both techniques of which result in poor quality shea butter with limited applications in the food and cosmetic industries at the local and international markets.

Methodology

Fractionation is a method for separating shea butter into two components namely: Olein (liquid) and Stearin (solid) fraction for various industrial applications. There are (3) three common methods for fractionating fats like shea butter, namely: dry fractionation, solvent fractionation, and detergent fractionation (Ünsal & Aktaş, 2003). In this case, artisan and cold pressed shea butter samples were fractionated using dry and solvent methods into olein and stearin fractions. Dry fractionation is a simple, cheap and popular technique where molten fat is cooled at different temperatures to form crystals that are subsequently separated by centrifugation or filtration. Solvent fractionation on the other hand, is a more efficient method of crystallizing molten fat in the presence of a solvent like acetone or hexane then filtering and evaporating the solvent. Two temperatures - 150C and 200C were applied to crystalize molten shea butter samples for the entire experiment. Fractions from both dry and solvent methods were then assessed for fractionated yield, quality and their potential in the formulation of cosmetic and food products. Quality of shea butter fractions were assessed for physical and chemical properties including refractive index (RI), iodine value (IV) and fatty acid (FA) profile at both crystallization temperatures.

Research, Results & Conclusion

The solvent fractionation method produces higher yield for the liquid shea olein than the dry fraction methods for both artisans processed and cold pressed shea butter samples.

Table 1: Solvent fractionation % Olein and Stearin yields of Artisan processed and Cold pressed Shea butter.

Shea butter sample*	Crystallization Temperature (0C)	Percentage yield (%)	
		Shea olein	Shea stearin
Cold pressed processed shea butter	15	41.5±1.0	58.5±2.0
	20	41.8±0.5	58.2±1.9
Artisan processed shea butter	15	59.4±2.0	40.6±2.5
	20	59.8±1.6	40.2±2.1

***Agitation speed 25 rpm**

Using solvent fractionation methods, artisan processed shea butter produced higher olein fraction yields than the cold pressed shea butter samples at both crystallization temperatures of 15oC and 20oC. Therefore, use of acetone solvent in shea butter fractionation shows higher degree of separation of olein fatty acids from stearic fatty acids.

Table 2: Physical and Chemical Properties of Olein and Stearin fractions of Shea Butter extracted by cold pressing and hot-pressing methods.

Shea butter samples	CT (0C)	AV (mg/KOH/g)		IV (I2g/100g)		Refractive index	
		OF	SF	OF	SF	OF	SF
CP	15	6.65±0.92^{a}	2.64±0.26^{a}	6.65±0.92^{a}	2.64±0.26^{a}	6.65±0.92^{a}	2.64±0.26^{a}
	20	12.35±2.03^{b}	4.32±0.08^{a}	12.35±2.03^{b}	4.32±0.08^{a}	12.35±2.03^{b}	4.32±0.08^{a}
HP	15	4.08±1.08^{a}	3.20±0.37^{a}	4.08±1.08^{a}	3.20±0.37^{a}	4.08±1.08^{a}	3.20±0.37^{a}
	20	3.31±0.18^{a}	2.40±0.07^{a}	3.31±0.18^{a}	2.40±0.07^{a}	3.31±0.18^{a}	2.40±0.07^{a}

Note: Significant different compared between CTs and shea butter samples

In terms of quality, the fatty acid value of olein fractions for cold pressed shea butter were higher than that of artisan processed at the respective crystallization temperatures, though within the standard limits for fats and oils. Iodine value of olein fraction of cold pressed processed shea butter was not significantly different from that of artisan processed shea butter samples at both crystallization temperatures 15oC and 20oC, but this was not the case for the stearin fraction. The refractive index of olein fractions were not significantly different ($p \leq 0.05$) for artisan processed and cold pressed processed shea butter samples that were fractionated at crystallization temperatures of 15oC and 20oC.

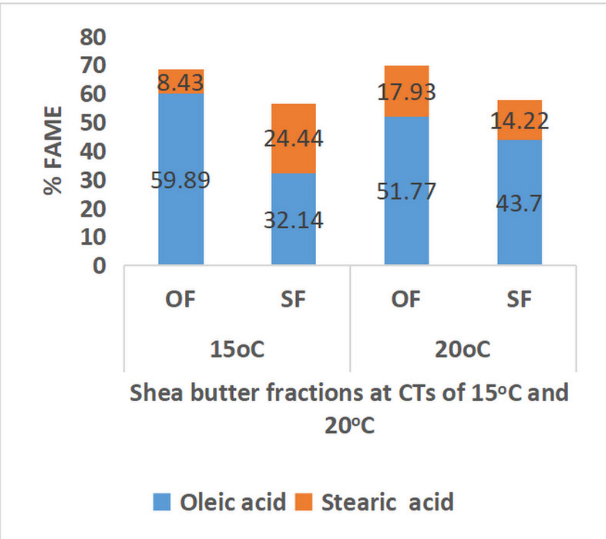

Figure 1: Fatty acid profile of OF and SF of CP shea butter at CTs of 150C and 200C

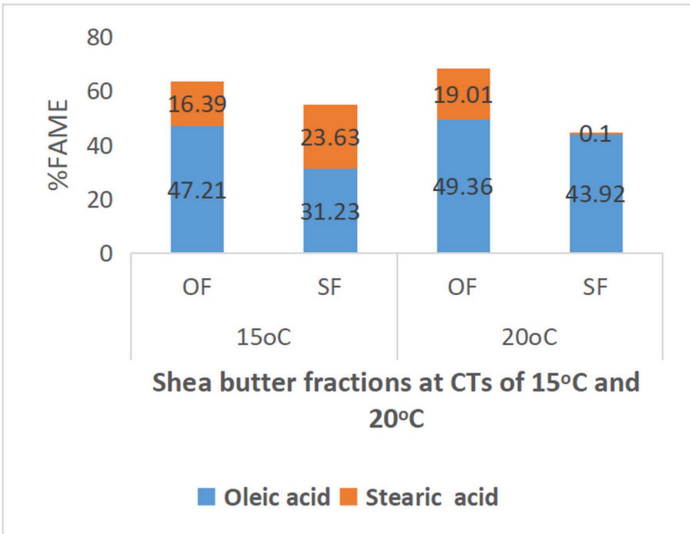

Figure 2: Fatty acid profile of OF and SF of HP shea butter at CTs of 150C and 200C

Artisan processed shea butter samples contained a higher amount of oleic acid fatty acid compared to that of cold pressed processed shea butter samples. The oleic acid fatty acid of stearin fraction of cold pressed processed shea butter sample was not significantly different at crystallization temperatures of 15oC and 20oC. Using the laboratory model (results), a pilot machine was fabricated for fractionation of shea butter fractions for industrial application.

Implications of the Findings

- Solvent fractionation method can be used for artisan processed shea butter into shea olein for cosmetic industrial application. Acetone is a suitable solvent for fractionation of shea butter.
- Dry fractionation method can be used to produce shea olein and shea stearin fractions from cold pressed shea butter as salad oil and confectionery butter.
- The crystallization temperature of 15oC was found suitable for separating artisan processed and cold pressed processed shea butter, and was as such considered in the fabrication of a pilot Shea Butter Fractionation Machine.

Conclusion

The solvent fractionation method yields higher content of olein fraction from shea butter with artisan processed shea butter registering higher values than cold processed shea butter. The crystallization of 15oC yields higher olein fraction from shea butter. The quality of fractionated shea butter components was within the national parameters.

Policy Implications/Recommendations

Shea Butter development is prioritized in the National Development Plan (NDP) III. In order to ensure efficiency, quality and global competitiveness of Uganda's Shea butter industry, the following are the emerging policy implications of this intervention:

Promote Solvent Extraction Technology

a. Develop training programmes for women, small scale practitioners and local artisans to build their capacities in fractionating technology and fabrication of low-cost fractionating machines.

b. Support research that further explores this and other appropriate technologies geared to optimizing shea production.

c. Conduct awareness campaigns for the solvent extraction technology.

Standardize processes for Shea Production

a. Develop and implement standards for shea butter production for purposes of consistency and quality assurance in the local industry.

b. Establish certification programs for shea actors who optimize their production processes, to facilitate their access to global markets.

Invest in Technology and Infrastructure

a. Pilot production of Fractionation Machines that utilize the crystallization temperature of 15°C, through public-private partnerships, to ensure the former's accessibility to shea actors across the board.

b. Scale up production of fractionation machines.

Market and Export Promotion

a. Provide incentives e,g. tax, tariff waivers, low interest loans, to companies that export value added shea products.

b. Negotiate regional and international trade agreements that facilitate competitiveness of value added shea products outside Uganda.

Develop regulations protocols for ensuring the safe use and disposal of acetone and any other solvents deployed in fractionating shea butter.

3. References

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