APPLICATION OF HACCP-BASED SYSTEM TO SHEANUT/UNREFINED BUTTER PRODUCTION IN NIGERIA

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Abstract

Poor practices in the production of Shea nuts / butter as well as presence of free fatty acids and aflatoxins have been responsible for its low quality and trade exports from Nigeria. Excessive human contacts with the product, minimal intervention by the government regulatory bodies and lack of documentation of the process further exacerbate the problems. With the assistance of WTO-STDF, a national Sanitary and Phytosanitary (SPS) project was initiated and A HACCP-based study was conducted in the project which was used to examine the extant practices, identify the hazards, critical control points and limits, monitoring and corrective measures and proffer intervention recommendations. Altogether there are sixteen recommended intervention steps with seven in the kernel (Shea nuts) processing and nine in the Shea butter processing stage. The interventions are basically in the areas of good hygiene, good manufacturing practices and process control; there are also some, bordering on good agricultural practices. While machines were introduced to minimise human contact with the product other interventions are based on adoption of improved practices over the existing methods of production.

Keywords: Sanitary and Phytosanitary (SPS), Shea nuts / butter, HACCP, Aflatoxins, Nigeria

Abbreviations:

1. INTRODUCTION

Products of Shea tree [Vitellaira paradoxa] such as Shea kernels and butter have been used for a long time as food and cosmetics items and articles of trade. In some areas of Nigeria, use of Shea butter as food item goes beyond common usage as vegetable oil but as accompaniments. Lumps of Shea butter are tucked into cereal-flour meals and breakfast cereals for full culinary and health benefits. However, the numerous culinary and health benefits derivable from Shea butter are only known to a few; especially to those residents in the areas of production, which cut across the savannah breadth of the country and known as Shea belt.

While the Nigerians may be losing in the acclaimed benefits of Shea products, the economy is definitely deprived of derivable benefits of Shea products. This is due to massive illegal across-the-border trade in the border towns for example Shaki to neighbouring Republic of Benin.

To counter this challenge, efforts were made to strengthen the national capacity to produce consistently high quality and volume of unrefined Shea butter that meet international standards. Towards this end, a HACCP based approach was employed in studying the value chain of Shea butter production in Nigeria to address challenges of safety and quality of the product for the purpose of trade promotion in the international market and creating more awareness on safe practices internally. This study spans a period of two to three years and involves collaboration with various groups, stakeholders, layers of government and regulatory bodies. It also demands a paradigm shift from existing way of doing things; encouraging formation of strong rural association of women producers, buyers and local end users; and focussing attention of inspectors to safety and quality issues. The study was a sub-component part of WTO-STDF sponsored project – SPS Project 172.

HACCP is one of the food safety management systems, which has its origin in the US space programme but has been adopted into the management of hazards in the high risk food categories, most especially. However, for its adoption into various segments of food production because of its proven usefulness and to prevent neglect due to high cost of implementation and cumbersomeness, the FAO/WHO Joint Food Standards Programme has recommended and encouraged the adoption of HACCP-based approaches to non high-risk food components by government.

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3 FAO Food and Nutrition Paper 86: FAO/WHO Guidance to Governments on the Application of HACCP in Small and/or Less-developed Food Businesses
2. JUSTIFICATION

Arising from the study there were technical and procedural interventions that will ensure that the goals of the project were met. Moreover in order to ensure adoption and taking over ownership of the interventions, it is imperative that the various players in the value chain who had been involved from the inception stages of the project should be guided by series of training. This paper formed the basis for the training of a portion of some of the operators in the Project Intervention Areas. This group of Trainees is made up of Traders, Exporters and Standards Enforcement Officers.

3. METHODS

The HACCP Team\(^4\) comprised of regulatory officers, food establishment inspectors, food scientists and technologists, produce inspection officers, microbiologists, investment advisor and chemists. The team described the Shea kernel and butter and intended uses of the products. Thereafter field trip was carried out to ascertain existing production practices by witnessing production and interviewing the operators. A flowchart was thereafter constructed for the purposes of hazard analysis.

The findings were presented and recommended interventions were made periodically to the HACCP Team for scrutiny and reviewing. HACCP-based flowchart incorporating newly introduced equipment and improved units operation steps was drawn after consultation with equipment manufacturers and extension workers and approval by the HACCP Team. Shortly after installation at Pilot Plants in Selected Production Areas and test running, training was carried out to introduce the areas of project intervention to the selected group.

3.1. Flow Diagrams for Shea kernel /Butter Production

Two sets each of flow diagrams depicting the Shea kernel and butter production processes were developed – a set showing the Shea kernel production before the STDF Project Intervention Figures 1 and 2; and those depicting the production steps incorporating the STDF project’s intervention steps in Figures 3 and 4 for Shea kernel and unrefined Shea butter respectively.

\(^4\) Appendix List of HACCP Team
Fig 1: Shea Kernel Production before the STDF Project Intervention
Fig. 2: Shea Butter Production before the STDF Project Intervention

FLOWCHART

Dried Shea Kernels

Cracking of Kernels

Roasting of Cracked Nuts

Milling of Roasted Nuts

Churning of Shea slurry

Heating of Churned Shea

Separation of Fat

Conditioning of Separated Fat

Packaging
3.2. Hazard Analysis

3.2.1. Shea Kernel:

The Shea tree is known to grow wildly, it is not planted and the task of fruit collection and processing is left to the women by the men folk. Therefore the hazards identified with the processing of Sheanut/butter are somehow related to the two aforementioned factors. The hazards include physical, biological and chemical hazards.

The wild cultivation of Shea tree resulted in the non ownership of the tree and the resulting lack of care. Thus its surrounding is expectedly untended and bushy. The fruits attract both man and animals especially snakes that are attracted by its flavour. This poses a problem at the point of picking by the collectors who stands the risk of snake bites. Apart from this physical hazard there could be biological hazard introduced by handlers and these could include the natural flora on the human body and others from poor personal hygiene and unsafe water sources.

Furthermore for each of the Unit process identified in Figure 1 and those recommended from the project intervention in Figure 3, the identified hazards with their sources of contamination and issues of concerns are enumerated in Figure 4. Identified possible physical hazards apart from snake venoms include contamination with animal dropping and virus from wild rodents. Also it may include contamination from the environment during drying which may be dusts, tree twigs, etc. Chemical hazards may include aflatoxins as metabolites of fungi, residues of pesticides and fertilizers from used bags, polycyclic aromatic hydrocarbons (PAHs) arising from smoke deposition and possible presence of high levels of heavy metals from inherent chemical properties of the kernel.

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5 Overview of the Intervention of PROMER in Shea Sector in the Department de Kedougou, Senegal Amadou Souare
Fig. 3: Project’s Intervention Flowchart for Shea Kernel Production
Fig. 4: Tabulated Hazard Analysis for Shea kernel

**Hazard Analysis for Shea kernel**

<table>
<thead>
<tr>
<th>FLOWCHART</th>
<th>TYPE OF HAZARD</th>
<th>SOURCE</th>
<th>ISSUE OF CONCERN</th>
<th>CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAND CLEARING AND CONTINUOUS CLEANING</td>
<td>Physical, Biological</td>
<td>Snakes, Rodents, Games</td>
<td>Contamination with Snake venom, droppings and Virus</td>
<td>GAP</td>
</tr>
<tr>
<td>COLLECTION OF NUTS</td>
<td>Biological, Chemical</td>
<td>Handlers</td>
<td>Contamination with Mould, Mycotoxins</td>
<td>GAP/GHP</td>
</tr>
<tr>
<td>SORTING OF NUTS</td>
<td>Biological, Chemical</td>
<td>Handlers</td>
<td>Contamination with moulds (Survival upon Multiplication)</td>
<td>GHP/GMP</td>
</tr>
<tr>
<td>TRANSFER TO PILOT PLANT &amp; IMMEDIATE PROCESSING</td>
<td>Biological, Chemical</td>
<td>Chemicals residues in Bags</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOILING OF NUTS</td>
<td>Biological, Chemical</td>
<td>Water, Smoke</td>
<td>Survival of Moulds; PAHs</td>
<td>Process Control</td>
</tr>
<tr>
<td>IMPROVED SUN DRYING</td>
<td>Physical</td>
<td>Environment and Equipment</td>
<td>Iron chippings</td>
<td>GMP</td>
</tr>
<tr>
<td>SORTING</td>
<td>Biological Chemical</td>
<td>Handlers</td>
<td>Recontamination by Mould</td>
<td>GMP</td>
</tr>
<tr>
<td>PACKAGING INCLUDING LABELLING</td>
<td>Physical Chemical</td>
<td>Handlers, Chemical residues in bags,</td>
<td>Moisture, Rodents, Sun and Heat, Pests; PAHs</td>
<td>GMP</td>
</tr>
<tr>
<td>STORING</td>
<td>Biological Chemical</td>
<td>Environment</td>
<td></td>
<td>GMP</td>
</tr>
<tr>
<td>MARKETING / SALES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.2.2. **Unrefined Shea butter:**

While the dried nuts if properly processed have been known to store for up to 3 years, the processing of Shea kernels to unrefined Shea butter also comes with its own hazards. The identified hazards based on the production flowchart Fig 2 and the Project’s Intervention Flowchart for Shea butter (Fig 5) are shown in Fig 6.

The identified hazards are similar to that of kernel especially in the biological hazards. The possible chemical hazards are now more pronounced because of processing by machines and depositon of PAHs through contaminations by smoking, rancidity from greater surface areas exposure of butter to air and sunlight from poor storage. While some of these might not be safety issues, they play a vital role in the final quality of the product; and are considered since safety and quality are the focus areas of the STDF Project.
Fig. 5 Project’s Intervention Flowchart for Shea butter

PROJECT INTERVENTION FLOWCHART

- Selection of Dried Shea Kernels
- Crushing of Kernels
- Roasting of Crushed Kernels
- Milling of Roasted Kernels
- Churning of Shea slurry
- Heating of Churned Shea
- Separation of Fat
- Cooling at of Fat at ambient temperature
- Packaging and Labelling

- Indirect Heating
- Mechanical Churning
- Indirect Heating
- Filtration
### Hazard Analysis for Shea butter

#### FLOWCHART

<table>
<thead>
<tr>
<th>Steps</th>
<th>Type of Hazard</th>
<th>Source</th>
<th>Issue of Concern</th>
<th>Control Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection of Dried Kernels</td>
<td>Physical, Biological</td>
<td>Handlers</td>
<td>Contamination with microbes</td>
<td>GHP</td>
</tr>
<tr>
<td>Crushing of Kernels</td>
<td>Biological, Mechanical</td>
<td>Crushing Machine and Handlers</td>
<td>Contamination with Fungi; lubricants, metals</td>
<td>GHP &amp; GMP</td>
</tr>
<tr>
<td>Roasting at 120°C for 1h 45min</td>
<td>Chemical</td>
<td>Heat</td>
<td>Contamination with metals, PAH</td>
<td>Process Control</td>
</tr>
<tr>
<td>Milling of Roasted Kernels</td>
<td>Biological, Physical</td>
<td>Milling machine</td>
<td>Contamination with left over, metals, oils</td>
<td>GHP &amp; GMP</td>
</tr>
<tr>
<td>Churning powdered shea into Slurry</td>
<td>Biological, Chemical</td>
<td>Handlers, Water</td>
<td>Contamination with microbes, sweat, chemicals</td>
<td>GHP &amp; GMP</td>
</tr>
<tr>
<td>Heating of slurry at 105°C for 1h</td>
<td>Physical, Chemical and Biological</td>
<td>Heat</td>
<td>Contamination with PAH</td>
<td>Process Control</td>
</tr>
<tr>
<td>Separation &amp; Filtration of Fat</td>
<td>Physical &amp; Biological</td>
<td>Filter, Handlers, Container</td>
<td>Odour, Colour, Contamination with Chemicals, Microbes</td>
<td>GHP &amp; Process Control</td>
</tr>
<tr>
<td>Cooling of Fat at ambient temperature to form fat</td>
<td>Physical, Biological</td>
<td>Handlers, Environment</td>
<td>Contamination with Chemicals, Microbes, Sweat, Dirt, Contamination with Chemicals, Microbes</td>
<td>GHP</td>
</tr>
<tr>
<td>Packaging and Labelling</td>
<td>Biological, Chemical</td>
<td>Handlers, Environment, packaging material</td>
<td>Moisture, rancidity, pesticide, infestation</td>
<td>GMP</td>
</tr>
</tbody>
</table>

#### Notes on Intervention Steps

Altogether there are sixteen recommended intervention steps with seven in the kernel processing and nine in the butter processing stage. The interventions are basically in the areas of good hygiene, good manufacturing practices and process control; while some border on good agricultural practices. Machines were introduced to minimise human contact with the product and other interventions were based on adoption of improved practices over the existing methods of production. Listed in the table below (Fig. 7) are the intervention steps, justification and recommended medium.
### Figure 7: Justifications for Recommended Project Intervention Steps

<table>
<thead>
<tr>
<th>s/n</th>
<th>Product</th>
<th>Unit Process</th>
<th>Project Intervention</th>
<th>Justification</th>
<th>Medium of Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shea Kernel</td>
<td>Farming</td>
<td>Weeding and Continuous Clearing</td>
<td>Need to minimise risk of snake bites and microbial contamination</td>
<td>Farmers Guide</td>
</tr>
<tr>
<td>2</td>
<td>Sorting</td>
<td></td>
<td>Introduction of Sorting of Fruits</td>
<td>Non existence</td>
<td>Guide or SOP</td>
</tr>
<tr>
<td>3</td>
<td>Transfer for Processing</td>
<td>Timely Transfer</td>
<td>To prevent /minimise biochemical changes leading to FFA</td>
<td>Farmers Guide or SOP</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Boiling</td>
<td></td>
<td>Use of Clean Water for Processing</td>
<td>To minimise microbial contamination</td>
<td>Sinking of Borehole</td>
</tr>
<tr>
<td>5</td>
<td>Sun drying</td>
<td></td>
<td>Introduction of Improved Sun dryer</td>
<td>To improve rate of drying, prevent contamination and rewetting</td>
<td>Provision of Improved Sun Dryer</td>
</tr>
<tr>
<td>6</td>
<td>Sorting</td>
<td></td>
<td>Introduction of Sorting of Dried Kernels</td>
<td>To introduce grading and remove infested kernels</td>
<td>SOP</td>
</tr>
<tr>
<td>7</td>
<td>Packaging and Labelling</td>
<td>Introduction of Jute bags for packaging and Introduction of Labels</td>
<td>To prevent infestation, promote aeration and improve traceability</td>
<td>SOP</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Shea butter</td>
<td>Selection</td>
<td>Raw Material Specification and Check</td>
<td>To ensure consistency in high quality production</td>
<td>SOP</td>
</tr>
<tr>
<td>9</td>
<td>Crushing</td>
<td></td>
<td>Introduction of Stainless steel plated crusher</td>
<td>To reduce incidences of heavy metal introduction and heat generation</td>
<td>Provision of equipment</td>
</tr>
<tr>
<td>s/n</td>
<td>Product Unit Process</td>
<td>Project Intervention</td>
<td>Justification</td>
<td>Medium of Intervention</td>
<td></td>
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<td>---------------</td>
<td>------------------------</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Roasting</td>
<td>Introduction of Indirect Heating</td>
<td>To reduce incidences of smoke deposition</td>
<td>Provision of Roaster</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Milling</td>
<td>Introduction of Stainless Steel plated Milling machine</td>
<td>To reduce incidences of heavy metal introduction and heat generation</td>
<td>Provision of Equipment</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Churning</td>
<td>Introduction of Stainless steel plated Churner</td>
<td>To reduce microbial contamination by eliminating human contact</td>
<td>Provision of Equipment</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Heating</td>
<td>Introduction of stainless steel plated indirect Heater</td>
<td>To remove all non butter impurities.</td>
<td>Provision of equipment</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Separation</td>
<td>Introduction of series of machines</td>
<td>To separate, clarify and dehydrate the butter</td>
<td>Provision of clarifier, butter washing machine and dehydrator</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Cooling</td>
<td>Conditioned environment for cooling</td>
<td>To prevent odour absorption and encourage rapid smooth solidification of butter</td>
<td>SOP</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Packaging and Labelling</td>
<td>Use of regulatory approved packaging materials and mandatory labelling information</td>
<td>To ensure consistent production of high quality product.</td>
<td>SOP</td>
<td></td>
</tr>
</tbody>
</table>
3.3. Identified Critical Control Points, Establishing Limits, Monitoring Systems and Corrective Actions

Critical Control Point is defined as a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level. Strictly, identifying critical control points is a function of ensuring safety in process control. Four and three of such points were identified for Shea kernel and Shea butter value chains respectively. For Shea kernels the critical control points as shown in figure 8, include the following: Sorting of Nuts, Boiling, Sun drying and Sorting of Dried nuts; and for Shea butter the points include Roasting, Heating and, Extraction and Filtration (Figure 9). While some of these identified points may be addressed by good hygienic and/or manufacturing practices but since the focus of the project is both safety and quality they are all considered.

Critical Limit is the maximum and/or minimum value to which a biological, chemical or physical parameter must be controlled at a CCP to prevent, eliminate or reduce to an acceptable level the occurrence of a food safety hazard. The tolerance for moldy nuts is 2% with adequate drying; good handling maintain low moisture content at later stages ensures 4% (max) aflatoxin content\(^6\); records for parboiling reflects that the best quality both in appearance and low free fatty acid is obtained with constant stirring during parboiling for 20 to 30 minutes\(^7\). The average temperature of 35°C for sun drying at elevated position for 11 days has been found to give best drying. Sorting of dried kernel at this stage is very critical to prevent or minimize consequent aflatoxins development from moldy kernels.

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\(^6\) African Standard for Shea Kernel

\(^7\) The effect of Traditional Primary Processing of the Shea Fruit in the Kernel Butter Yield and Quality. P.C. Aculey, S.T. Lowor, W.O. Kumi and M. K. Assuah
The identified three critical control points for unrefined butter namely roasting, heating and separation of fat by filtrations have the critical limits shown in Figure 9 under the critical limits column. For roasting, a temperature of 120°C for a duration of 1 hour and 45 minutes; for heating a temperature of 105°C for 1 hour were identified. Proper separation of fats and dehydrating the resultant butter is important to reducing moisture and probability of recontamination and rancidity.

The various monitoring systems and required corrective measures include: carrying out on batch basis, visual examination for percentage mould and rejecting the batches that fail; for boiling, monitoring the temperature and the duration which could be corrected by either reducing or increasing the heat and/or duration; sun drying will require monitoring of ambient temperature, air current and the corrective measure will be reduction/increase of time or degree of exposure; for roasting and heating systems measures used for controlling boiling will also suffice; while for separation and filtration, recording flow time and clogging of filter materials will serve for monitoring and replacement or cleaning of filter for corrective measures.
3.4. Verification and Documentation:

The production system will be verified by constant inspection and applying necessary modifications until the processing lines stabilize. At each of the unit processing step, required documentation have been identified and they include: % mouldy rejects; record of receipt – name, source, date, quantity, etc; °T and Time in minutes, hours or days; quantity released to store and also laboratory results on samples of production in respect of moisture content, heavy metals, aflatoxins and FFAs.
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