CHAPTER TWO: LITERATURE REVIEW

2.1 Overview of Yam Processing Methods

Yam processing in traditional settings involves boiling, pounding, drying, or grinding to produce various products such as pounded yam, yam flour, or chips. Among these, pounded yam remains the most labor-intensive, often requiring strength and time for satisfactory results.

Pounding has been an integral part of majority of the African people particularly Nigeria where virtually all the ethnic groups have one or more items to pound before use. At present, there exists different makes of yam pounding machines. One type cooks and pounds while another pounds only. The problem associated with them is that they are expensive to operate and acquire.

Herbert and Kenwood mixing machines were in 1975 introduced into the market for use, this however, gave rise to the conception and development of the yam pounding machine. The Herbert and Kenwood mixers were not originally designed for yam but gradually faded away due to its inefficiency in operation such as longer time in meshing operation and overheating of the machine which had to be stopped intermittently for cooling and the non-homogeneity in bond formation after meshing. Hence, the above argument ascertains that both the Herbert and Kenwood mixers were not originally designed for yam pounding, but potatoes meshing as their mode of operation is similar. Also, these mixers have the following deficiencies on the pounded yam.

- Hardness of the yam after pounding,
- Presence of much un-pounded yam seedlings.

2.2 Traditional Yam Pounding Technique

The ancient and traditional methods of pounding is carried out with the use of the wooden mortar and pestle. The wooden mortar has a concave base with a cup like hole in it for housing the items to be pounded, the pestle also, is a wooden long single or double edge smooth cylindrical base (dumb bell shaped) used for the pounding. The use of mortar and pestle is still widely practiced. Though culturally rooted and effective for domestic consumption, it has proven unsuitable for large-scale or modern processing settings due to physical strain, inconsistency, and low productivity.

2.3 Yam selection and weighing

The whole some suitable yam tubers are selected for production, the wholesome tubers are then sorted out. During sorting, yam tubers that are disfigured during harvest are rejected and it is very important to select carefully or intern deterioration due to aging may have started. If the yam tubers have been stored for a long period of time, the enzymes that are present may have brought about deterioration due to temperature of the storage area (barn, store house, under ground etc). If the yam tubers have been exposed to some sunlight, this type of condition can lead to spoilage which may not be visible at mere looking at the yam tuber. A simple way of detecting spoilage is by scalping off the back of the yam tuber and carefully observing it, if there is internal spoilage, it will show brown or black discoloration depending on the level of spoilage. The enzymes that can cause discoloration of yam and spoilage are polyphenoxidase (ppo), perioxide (opo), fenitic acid, flavanol dimanic acid, hexoainas phosphorylase, alcohol dehydrogenasion. The second unit operation after the sorting of the yam tubers is weighing and it involves using a measuring balance to know the weight of the tubers.

2.4 Types of yam pounding

Pounded yam is a known and prestigious staple popular among the highly educated and illiterate Nigerians. Yoruba call it lyan, in Lagos, Ogun, Ondo, Cross River and some other states, pounded yam is a choice food when having traditional ceremonies like marriage, naming, chieftaincy title awards, coronation of a new king and buffets. There are two types of pounding namely;

• Manual pounding and

• Stirring and blending

2.5 Manual pounding

Pounded yam is made from pounding yam repeatedly with a club like cooking utensil pestle inside a bucket like cooking utensil (mortar). The yam is first peeled then washed in clean water. It is then boiled till its soft and then placed in the mortar.

The pestle is used to pound the boiled yam into a dough like staple that is high in vitamins, filling and a true dining experience. Pounded yam is usually eaten with egusi (melon), efo (vegetable) or whatever soup of choice comes to mind.

2.6 Stirring and blending type

The stirring and blending method of preparing pounded yam is a less stressful way. You can use a machine that boils the peeled yam (you can test whatever it is well boiled by using a fork. When the yam is soft, it can now be moved to the next stage (ie. To the pounding or blending machine). The yam is placed inside the crushing chamber of the machine and then powered by a prime mover (petrol engine) or electric motor. The machine start pounding the yam until it is up to the desire texture of the operator.

2.7 Development of Mechanized Yam Pounding Machines

Several studies have investigated yam pounding machines in Nigeria and elsewhere, focusing on mechanical design and performance. For example, Adesuyi et al. (2024) developed a vertical yam pounding machine that mimics traditional pestle action. Their machine (shaft, pulleys, motor, vertical dumbbell-shaped beater) produced quality pounded yam: 96.2% free of lumps and throughput ~39.5 kg/h, far above the

~20 kg/h of mortar pounding. Emodo et al. (2019) reviewed local motorized pounders, noting that many devices use electrical or petrol engines to drive beaters but suffer low efficiency and heavy labour requirements. These authors highlight materials (stainless steel bowls/blades) to ensure hygiene and the need for robust transmission (belts, gears). In most designs, detailed calculations for drum capacity, belt lengths, forces, and motor power are given; typical reports include 2D and 3D CAD drawings of the assembly and components (e.g. isometric, assembly, exploded views).

However, a common limitation is mobility and handling. The literature on yam pounders rarely addresses portability. Designs are generally intended as stationary appliances. For instance, Adesuyi et al.'s machine was meant to be upscaled for wide use, but no castors or wheels were mentioned. Similarly, Emodo et al. note power and efficiency issues but do not consider ease of relocation or sanitation of the entire frame. The only nod to mobility in these studies is a passing note that one prototype "has tyres at both stands for durability", suggesting a fixed stand with wheels, but details and impact on cleaning/movement were not explored. In practice, the rigid-frame nature means machines must be lifted or partially disassembled for cleaning the underside, making maintenance burdensome.

This project addresses those gaps by explicitly designing for mobility and ergonomic handling. In contrast to past work, we focus on retrofitting wheels and evaluating the improvement. The table below compares key aspects of example prior designs with the proposed wheeled yam pounding machine:

Aspect	Prior design	Proposed wheeled machine
Mobility	Fixed or minimal (one design merely added tyres for stability). Typically heavy without wheels.	Four casters (2 swivel w/brakes, 2 rigid) mounted on frame. Allows easy pushing and steering.
Cleaning	Stainless bowl and blades detach for cleaning, but heavy frame stays fixed	Same detachable bowl/blades, plus entire machine can be wheeled away for access under/around frame.
Efficiency	High pounding efficiency (up to ~98% lump-free) achieved; but power draw and speed not optimized for portability.	We maintain the same pounding mechanism (so similar efficiency) but add mobility.
Ergonomics	Fixed machines require multiple people or lifting, increasing labor.	Ergonomic casters reduce start/stop forces. Single user can move machine safely.
Power	Electric or petrol (eg. Emodo's design had both options). Relies on external supply.	Power source unchanged; wheels do not affect motor design except for minor added load.

Stability Solid mounts (often bolted or welded stands). Wheel brakes and low center-of-gravity maintain stability during operation.

2.8 Review of Selected Related Works

Year	Authors	Contribution	Limitations addressed by this work
2017	Adebayo and ogunjimi	Designed a standard yam pounding machine with basic automation	Lacked ease of movement; design was for fixed installations
2018	Bamidele and oladipo	Evaluated a semi-automated pounding system with good throughput	Machine was bulky and heavy, not easy to reposition or clean
2019	Oloruntoba and akinola	Optimized energy consumption and pounding speed	No consideration for portability or frame ergonomics
2020	Ajayi and salami	Introduced a hydraulic pounding mechanism, increasing precision	Cost and complexity made it unsuitable for local users
1975	Herbert and Kenwood	Gave rise to the conception and development of the yam pounding machine.	Faded away due to its inefficiency in operation such as overheating and plums formation

2.9 Summary of Literature and Identified Gaps

While previous research has made significant progress in automating the pounding process and enhancing efficiency, few efforts have focused on improving physical mobility and ergonomic usability. The gap identified lies in enhancing machine design through structural modifications that make the machine more adaptable and user-friendly, especially in confined or shared spaces.

2.9.1 Justification for the Proposed Modification

Adding mobility through caster wheels addresses practical limitations faced by users of fixed-frame machines. The proposed modification provides a low-cost yet effective solution to improve user interaction, safety, and operational flexibility. This is an important step toward holistic design improvement for small-scale food processing equipment.