THE CENTRIFUGAL FUFU POUNDER

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ABSTRACT

*The paper describes two centrifugal machines for pounding Fufu, a West African meal. The first machine is the Nigerian/Japanese Yam Pounder which is capable of pounding only yam. The second is called the *KEDOAN, an acronym coined after the names of the inventors; it pounds into Fufu the four basic foodstuffs (yam, plantain, cocoyam and cassava) and their combinations satisfactorily in less than 5 percent of the time required by the indigenous approach. That is, it produces the right texture of Fufu without any lumps whatsoever over a process cycle of much less than one minute to serve about three people of normal appetite for Fufu.*

1. INTRODUCTION

A few innovations based on various design principles have evolved in an attempt to mechanise the preparation of Fufu, a popular West African meal. Hence, two grades of machines have been designed and apparently tried. At the lower grade is the machine-assisted unit in which the human energy expended only in pounding Fufu is mechanised; the concomitant turning and mixing of the foodstuff and application of water to promote the right texture and consistency are achieved in the usual manner by means of the human hand in this unit (see Fig. 1). Having a little more complexity is the slightly higher grade machine which is designed to eliminate human intervention in almost all the areas of Fufu preparation except probably watering, hence, minimal human energy is required in this unit (see Fig. 2).

In the first grade is found the connecting rod and crank arrangement which actuates the reciprocating movement of the pestle that does the pounding of the foodstuff gathered in a mortar. In the second grade are shredders/extruders. In this arrangement a screw transporter carries the shredded carbohydrate through a conical cage and in the course of its transport, the carbohydrate is mashed and eventually forced through an orifice, thus providing a measure of pounding and mixing or turning (see Fig. 2).

Reports on trials with these and other mechanical Fufu pounding units indicate that no appreciable successful results have been achieved by means of these contraptions. It is apparent that the best results with these units are produced on yam, even though the final product is reported to have consistency and plasticity that are noticeably different from Fufu as demanded and enjoyed in Ghana and most other West African countries like Nigeria, Togo and Ivory Coast. It is noteworthy that an attempt has also been made to produce Fufu by the passage of the carbohydrate into direct contact with a gear train; its success is also with yam only.

It appears from all accounts on Fufu pounding that the application of the purely reciprocating or rotary action to the foodstuff succeeds only in mashing or squashing it without producing the smooth, plastic and homogeneous Fufu known to most Ghanaians. Therefore, a Fufu pounding machine capable of taking the pounding process beyond the mashing stage is desired.

Past inventors of the machine either inadvertently overlooked or failed to realise the unique potential of the centrifugal action for pounding foodstuff. It is easily conceivable that a centrifugal force may be repeatedly imparted to the foodstuff in order to pulverise it by means of a rotating impeller or blade as in numerous domestic grinding devices. Two such pounders, the Nigerian/Japanese Yam pounder and the KEDOAN, are described in the following sections to demonstrate the capabilities of the centrifugal principle in producing Fufu to meet Ghanaian standards of texture and consistency.

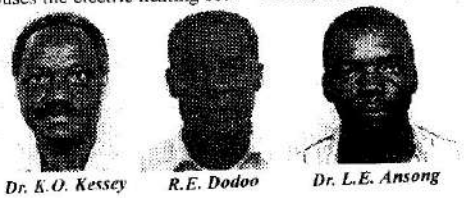
Mention should also be made of the marketing of instant powders of carbohydrates from which Fufu may be prepared by simple mixing in water and kneading while heat is applied to the receptacle. For most of these powders, potato starch is invariably used as the binder. The final product from these mixes lacks the plasticity known for Ghanaian Fufu. Nevertheless, the realisation that the dry powdery food mix can yield a product having a reasonably good Fufu texture, though not to the ultimate standard required by Ghanaians, readily points to the direction mechanical Fufu pounding machines must aim at. To ultimately produce a wet powder prior to binding! The two centrifugal machines will clearly demonstrate that a machine that is capable of pulverising the boiled foodstuff into a wet powder achieves the required result of a smooth, homogeneous Fufu to meet Ghanaian standards.

2. NIGERIAN/JAPANESE YAM POUNDER

This is a pounder designed by a lecturer at the University of Ife, for producing the typical Nigerian "pounded yam", as the Nigerians are delighted to call it, that is less plastic or sticky than the Ghanaian Fufu. Two versions are known to have been produced, one by a Nigerian manufacturer and another by a Japanese firm, presumably on the basis of the lecturer's design. The model is a rotary/centrifugal device that takes the raw chopped pieces of yam through the process of cooking followed by pulverisation and blending with a centrifugal action.

2.1 Description and Operation of the Yam Pounder

Fig. 3 is a sketch of the Nigerian/Japanese yam pounder. In operation, the raw chopped carbohydrate is fed into the main basin[2] in which the wing-like vane[7] is installed. Water is then poured into the water basin[3], which also houses the electric heating coil[4]. Hence, when the coil is



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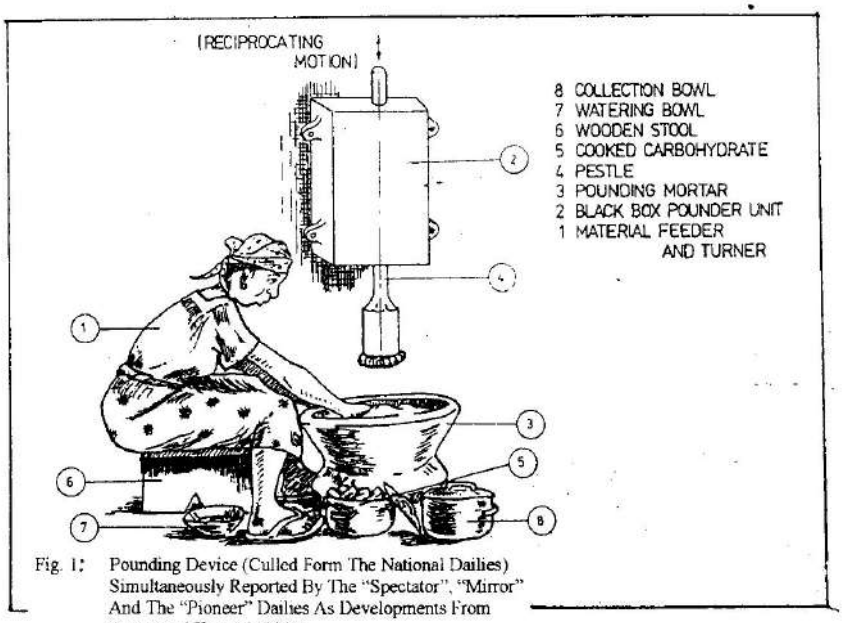

Fig. 1: Pounding Device (Culled Form The National Dailies) Simultaneously Reported By The "Spectator", "Mirror" And The "Pioneer" Dailies As Developments From Accra And Kumasi (1994)

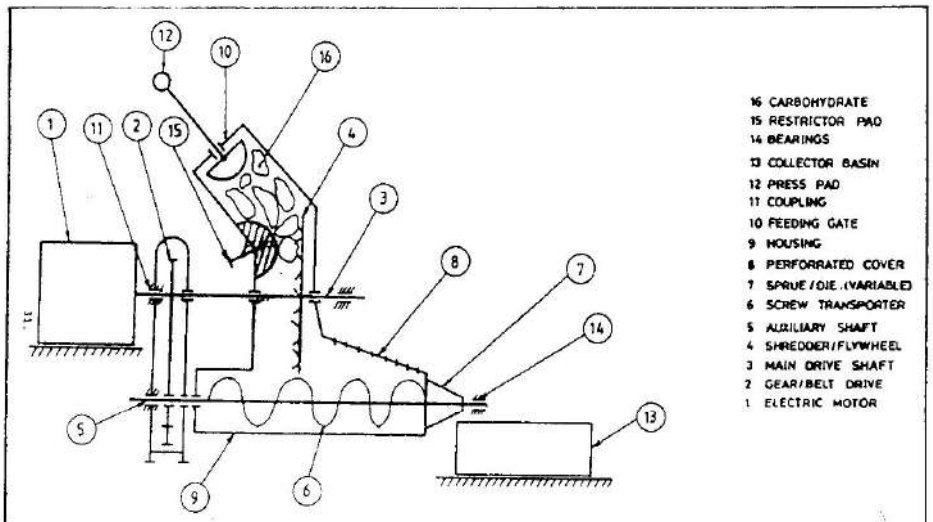

Fig. 2: Proposed Fufu Machine By Mr. Mireku Of The U.S.A

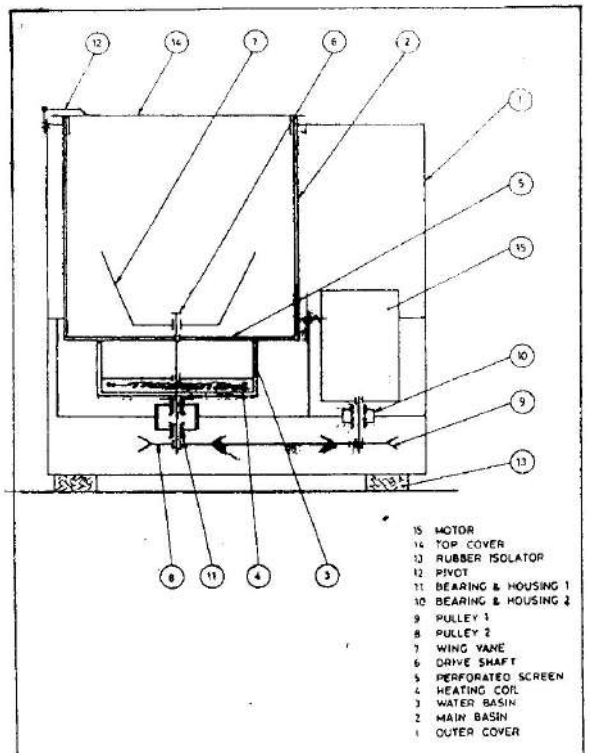

Fig. 3 Schematic Diagram Of Japanese University Of IFE Yam Pounder

energised, the water in the basin is heated to steam boil the carbohydrate. When the yam is found by inspection to be well cooked and tender, the electric motor[15] is switched on to rotate the vane which then pulverises the carbohydrate, thus finally blending it into a smooth, pasty stuff to produce the Nigerian type of Fufu known as the pounded yam.

2.2 Trial Runs of the Yam Pounder

The Nigerian/Japanese Yam Pounder has been tested with the four basic foodstuffs, namely, yam, plantain, cocoyam and cassava in order to assess its effectiveness in producing the Ghanaian type of Fufu from these staple foodstuffs.

The evaluation procedure was to weigh a quantity of particular foodstuff, feed it into the pounder, time the pounding process, and dish out the finished product from the pounder to a six-member panel of lecturers and technicians, including one female, who volunteered comments after sampling. Typical observations made by panelists for one of the many tests conducted on the yam pounder are summarised in Table 1. From the general observations made by the panelists, as detailed in the Table, it may be readily concluded that this Yam Pounder, deservedly so-called, can successfully pound only yam but has great difficulty in pounding the remaining foodstuffs. Even with yam, the panelists unanimously agree that the product's "texture is one between mashed yam and full-blown Fufu" and that "it requires some amount of water to bring it to the standard Fufu texture", to quote the panelists.

3. THE KEDOAN

The **KEDOAN** is a centrifugal Fufu Pounder named after its three inventors, KEssey, DOdoo and ANsong, of the University of Science and Technology (UST), Kumasi, Ghana. It is simple in design, and its parts perform well-known basic functions as described in the following section.

The KEDOAN Fufu Pounder is capable of pounding satisfactorily the four basic foodstuffs (plantain, cassava, yam and cocoyam) and their combination. It produces the right texture of Fufu which the Ghanaian likes, without any lumps whatsoever over a process cycle of approximately twenty seconds to serve about four people of normal appetite for Fufu to their satisfaction.

3.1 Description of the KEDOAN

The following parts of the KEDOAN are arranged in specific and functional relationship to make up the assembly of the machine.

1. Hopper	12. Rubber Damper
2. Bowl	13. Frame-Work
3. Gate	14. Sensor Module
4. Pounder	15. Hand Switch
5. Driven Pulley	16. Rubber Damper
6. Shaft	17. Water Reservoir
7. Anti-Friction Bearings	18. Control Valve
8. Friction Belt	19. Control Handle
9. Driver Pulley	20. Water Circuit
10. Electric Motor	21. Spray Heads
11. Base	22. Cover.

The aforementioned parts are as shown in Fig. 4.

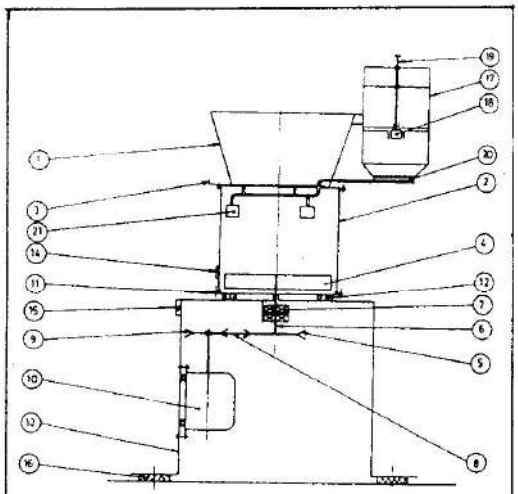

Fig. 4: Kedoan Fufu Pounder

TABLE 1: Typical Panellists' Comments on Japanese Yam Pounder

Type of Foodstuff	Yam	Plantain	Cassava	Cassava and Plantain
Technical Data	Weight 425gm Net Loss 88gm Total 513gm	660gm 46gm 706gm	1383gm 271gm 1654gm	1391gm 571gm 1962gm
Pounding Time	4 mins		5 min. Difficult	10 min. but difficult
General Observation	Successful	Unsuccessful	Unsuccessful	Unsuccessful
Comments by First Lecturer	Texture is very smooth and elastic. However it appears to be a little bit hard than the usual Fufu. It requires some amount of water to bring it to the standard Fufu texture.	It is a little bit hard compared to the yam. There are too many pebbles in it i.e. it is not very smooth.	The texture has lost its elasticity and plasticity. It is not near Fufu and has a lot of lumps in it.	This Fufu is soft and has a lot of lumps. It is not very plastic. compared to the normal fufu
Comments by Second Lecturer	Specimen is a little bit short of Fufu. The texture is one between mashed yam and full-blown Fufu.	Texture is not up to standard; too many pebbles.	Texture is not up to standard of Fufu and has too many pebbles.	Poor texture of Fufu with too many pebbles
Comments by Lady Stenographer	Texture will be OK after sometime for serving but it needs some water to make it a bit soft.	I feel it will be good for serving together with cassava.	I feel it will be good for serving if combined with a little plantain.	
Comments by Senior Technician	Texture is almost like the real Fufu used in many homes. It is OK.	Texture is quite OK. But not as sticky as expected		
Comments by Second Technician	Pounded yam is OK. It seems there is not difference to the local one.	Does not look like Fufu. It is too soft with many pebbles.		
Comments by Technician	The texture is very good. The temperature at which it was pounded was too high so the possibility of breaking down is high.	It is not much like plantain Fufu. It has not much plasticity in it.	Disappointing texture. Too many large lumps.	

During operation of the KEDOAN the cooked foodstuff (usually a carbohydrate) is fed into the hopper[1] and is prevented from entering the bowl[2] by the gate[3]. See Fig.4.

The pounding vane[4], simply called pounder, is rotated by means of a driven pulley[5] which is connected to the pounder through a vertically mounted shaft[6] installed in appropriate bearings[7]. This pulley is in turn driven through a friction belt[8] by the driver pulley[9] coupled to the electric motor[10], the main source of power.

The base[11], which carries the bowl, rests on rubber dampers[12] embedded on top of the frame-work[13]. The dampers are provided to reduce vibrations transmitted from the driver pulley and its driven members as well as minimise vibrations due to the pounder and pounding action of the bowl.

A sensor[14], designed and built at the request of the authors by Mr. G.E. Afari of the Electrical and Electronic Engineering Department of the UST, is attached to the bowl to trip off the electric motor at the appropriate time. The electric motor is switched on by means of the hand switch[15].

Water is added to the stuff by releasing water through the spray head[21] when the control handle[19] is manipulated to open the control valve[18]. Water from the Reservoir[17] flows across the opening into the water circuit[20], thus reaching the spray heads.

3.2 The Pounding Process of the KEDOAN

Prior to initiation of the pounding process, the foodstuff is first kept in the right quantity in the hopper with the gate in a closed or idle position. Consequently, the motor is started with the bowl completely empty and so the moving parts of the KEDOAN Fufu Pounder, such as the pounder and pulleys, begin their runs under no-load condition. While the machine is in operation with all the parts moving, the operator then draws the gate outward to create an opening which permits the foodstuff to drop steadily from the hopper by its own weight into the bowl, thereby hitting the rotating pounder on the top and sides.

The first contact between the pounder and carbohydrate produces two immediate effects. The carbohydrate is first disintegrated into particles or mashed stuff in an essentially pulverising action by the pounder. The second effect is random propulsion of the roughly mashed stuff in several directions by the pounder causing further pounding of the stuff against the bowl and indeed against parts of the pounder itself in an apparent boomerang fashion, thus yielding a smooth powdered stuff. The interaction between the bat and ball in the game of squash probably provides a good analogy to the propulsion / smashing - boomerang situation generated largely by centrifugal forces described above except that the ball is too hard for the bat to pulverise but only to propel.

Continuous propulsion of the smooth powdered stuff by the pounder causes noodles to form, initially in a rather chaotic movement until a little later when particles of the powdery foodstuff glue together and finally an orderly ball is formed, indicating the end of the pounding process. Water for softening and keeping the consistency right is added through the spray heads.

The closing stage of ball formation is characterised by more pronounced vibratory and impulsive forces. This could be employed to actuate the sensor attached to the bowl to trip off the electric motor and its drive and so end the pounding process. . Mr. Afari's control unit, which is normally pre-set to produce the desired result, automatically stops the process on completion. The pounded Fufu is then retrieved manually from the bowl by means of a hand spatula.

3.3. Noodle Formation in the KEDOAN

The scenario of pulverisation of the food-stuff and its noodle formation in the KEDOAN is quite spectacular. As mentioned above, the centrifugal forces generated by the rotating pounder largely propel the food particles to hit the bowl, from which they readily bounce back to the pounder in a reciprocal action like a boomerang. These persistent chaotic interactions produce in a short run lasting about tens of seconds a continuum of very fine powder like a harmattan sand blast in the dry season or snow flores in winter produced by a storm, but obviously on a very small scale in the KEDOAN.

Hence, having been thus reduced to the minutest size such that the centrifugal and reciprocal bouncing effects can no longer maintain the largely radial cross flows due to the marked reduction in particle weight, the particles are blown down to the periphery of the bowl. Consequently, as the rotating pounder sweeps them together they are mutually bonded to form a ball or noodle. The wetness of the initial foodstuff is largely responsible for the gluing together of the eventual wet powder formed.

It is therefore observed that the dressing phase, which is achieved by the human hand in the indigenous approach, is discernibly replicated by the rotating pounder vane to complete the pounding process in the KEDOAN. A perfect and timely ending of a successful pounding process, brought about by these apparent reciprocal effects, is evidenced by the formation of the ball of Fufu, smooth and homogeneous to Ghanaian taste and standard.

3.4 Claims of the KEDOAN

The prototype machine has been tested and following are among its claims:

- It is capable of producing Fufu within five percent of the known pounding time of the indigenous approach, whether by the commercial or domestic unit.
- It produces flawless pounding of all the four foodstuffs (cassava, yam, plantain and cocoyam) individually or their combination with the right texture and consistency and without lumps or pebbles.
- It achieves easily all the consistencies of Fufu such as "hard", "medium" and "soft" textures by the normal setting of the pounding vane.

4. CONCLUSION

The research for a mechanical device to pound one or a combination of foodstuffs to produce Fufu has centred around the reciprocating or rotary action for a long time with little or no avail. Current research and development by the authors has clearly established that the centrifugal action is capable of producing the fine powder desired in the all-important stage of pulverisation of the food-stuff prior to bonding into Fufu.

While the Nigerian/Japanese yam pounder based on the centrifugal action can produce only yam Fufu, the KEDOAN, also a centrifugal machine, is capable of producing

flawless Fufu from any of the four basic foodstuffs in much less than one minute to satisfy three people of normal appetite for Fufu. The product from the KEDOAN has the right texture of Fufu demanded by Ghanaians; Fufu having the desired homogeneity, plasticity and consistency.

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