A KITCHEN APPLIANCE FOR SHELLING EGUSI

by

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ABSTRACT

"Egusi" is the common Nigerian name for the food seeds considered to be of the Citrullus Sp. and inclusively known as "melon" seeds. On the basis of experience gained in the design and construction of a spinning disc "melon" seed shelling machine for large scale factory applications, a kitchen appliance of shelling egusi was designed. The prototype was constructed as an accessory to a kitchen blender. The performance test showed that the appliance performed satisfactorily with a shelling effectiveness of nearly 100% and minimum percentage breakage of about 8% at a capacity of about 10 kg/h.

1. INTRODUCTION

Egusi is the common Nigerian name for the food seeds loosely known as "melon" seed and variously designated as Citrullus edulls, Citrullus Vulgaris, Citrullus lanatus and Colocynthis Citrullus [1,2,3]. It is preferred here to use the Nigerian name, "egusi", which is more specific.

The author recently designed, constructed and tested a prototype egusi shelling machine at the request of a food processing firm. Intended for large – scale factory operation, that prototype was unsuitable both in size and capacity for a home kitchen. It was therefore, decided to design a shelling machine of a size suitable as a kitchen appliance. This was considered a good idea because it takes a housewife about 2h to shell enough egusi (~400gm) to make soup for an average family [4]. That is too long and too tedious for today's fulltime worker house wife. A kitchen appliance to shell egusi will be a welcome relief.

2. DESIGN CONCEPTION

Egusi is a small flat oval seed with a flat cotyledon enveloped in a thin-walled khaki or dust coloured shell. Fig. 1 shows the photograph of three common varieties of egusi grown in Nigeria. Close examination of unshelled

Fig. 1: some common varieties of egusi seeds.

dry egusi gives the feeling that the cotyledon is bedded in a cushion of air within the shell. The cotyledon appears to be loose within the shell or so weakly attached that it is readily shaken off when the shell is broken open. Considering that the unshelled seed is very small, having a mean major diameter of about 12 mm, intermediate diameter of 8 mm and diameter of 2.3 mm and weighing about 150 mg on the average [4] it was determined that the most appropriate mechanical method of shelling egusi is by impact. In this design, the seeds are confined to move on a fast spinning vaned disc and are projected there from to impinge on a concentric impact surface. As illustrated in Fig. 2, the component of the projection velocity normal to the impact surface provides the energy to split the egusi shell while the tangential component of the projection velocity supplies the rubbing force to shear and shake the cotyledon from the split shell. The design therefore, consists in choosing an appropriate combination of the radius and B, vane; C, impact surface; wR, tangential velocity; V_V, velocity relative to vane; V, resultant velocity; V_N, normal component of V on C, V_T, component of V tangential to C.

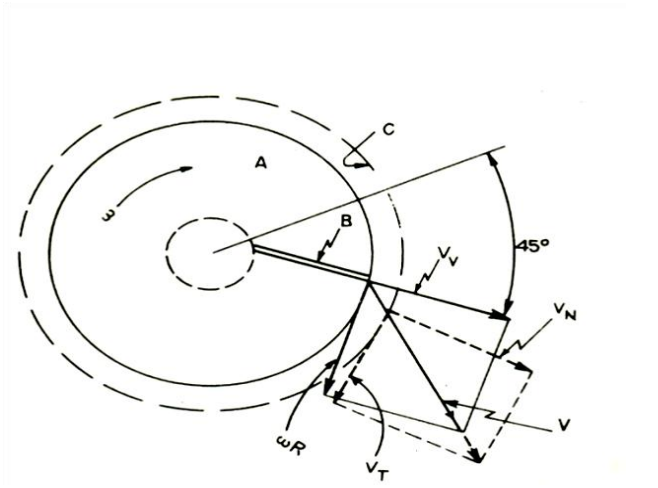

Fig. 2: Resultant velocity of seeds emerging from spinning disc A.

angular velocity of the spinning disc, the number and configuration of vanes on the disc as well as the distance between the disc periphery and the impact surface to give a good shelling efficiency.

3. THE PROTOTYPE EGUSI SHELLING APPLIANCE

The egusi shelling appliance, shown in Fig. 3 consists of a spinning aluminum disc, 160 mm in diameter, mounted horizontally on a vertical shaft. The shaft is connected by a clutch arrangement to the motor shaft of a disused electric blender and carefully secured in two bearings to run smoothly. The disc may spin at any of the 14 blender speeds designated in the increasing order as whip, stir, puree, beat, aerate, crumb, chop, grind, mix, grate, pulverize, churn, blend and liquefy. At the lowest or whip speed, the rpm is about 4000. Attached to the top of the disc are 3 mm thick Perspex vanes which extend from the periphery

Fig. 3 (a): photograph of appliance.

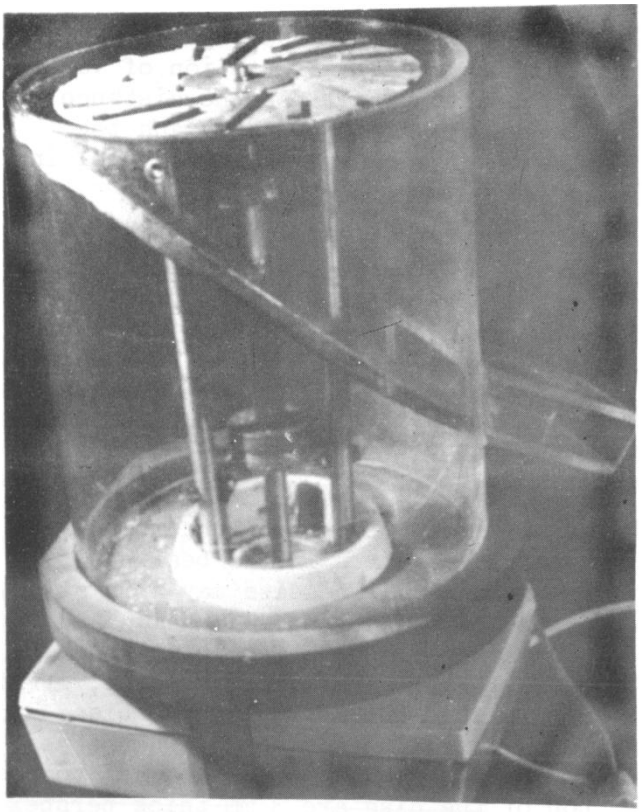

Fig. 3 (b): photograph of appliance with lid removed to show spinning disc.

to points 25 mm from the center to form the configuration shown in Fig. 4. This vane configuration was found to give the best shelling effectiveness of all others tested in the work in reference [4].

The spinning disc is positioned concentrically within a 190 mm dia transparent Perspex cylinder which extends 4 mm above the level of the disc to provide the impact surface for the egusi seeds projected from the disc. Thus, the distance between the impact surface and the spinning disc periphery is 15 mm. A lid, carrying a hopper, covers the Perspex cylinder in such a way that it is parallel to and 3.5 mm above the spinning disc and so just clears the Perspex vanes. The egusi seeds fed through the hopper onto the spinning disc are confined to move in the 3.5 mm space between the disc and the lid and between vanes on the disc. The flat-down preferred orientation of egusi seeds and their average thickness or minor diameter of 2.3 mm restricted them to move in a single-seed layer within this

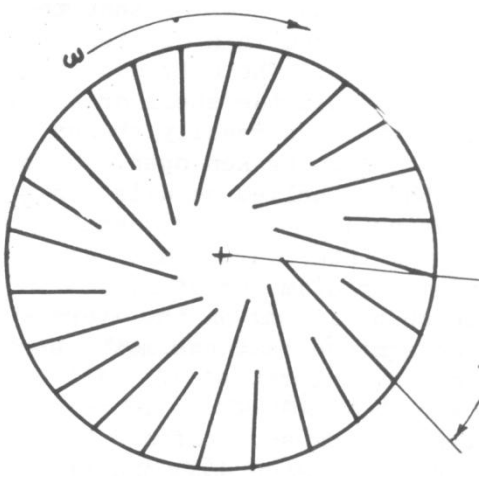

Fig. 4: Vane configuration used on spinning disc with vanes at 45^0 to radii of 50mm dia concentric circle.

available space.

As shown in Fig. 3, an aluminum plate is fitted within the Perspex cylinder, below the spinning disc, in a plane at 45^0 to the cylinder axis. The mixture of shelled egusi seeds and chaff falls on to this plate and slides down to the discharge spout for collection. The chaff is easily separated from the shelled seeds by winnowing. Easy flow of the mixture is ensured because the maximum coefficient of friction of the mixture on aluminum plate was determined to be 0.78 which is less than tg 45^0 .

The appliance, including the base of the disused electric blender, weighs about 2.5g. its overall height, including the hopper is 450 mm. Therefore, the appliance is portable and occupies little space in the kitchen. The design is such that any kitchen blender may be easily adapted to use the appliance without affecting its normal uses.

4.1 PERFORMANCE TESTS

Objective measures to test the performance of the egusi shelling appliance involved the determination of the percentage shelling effectiveness, percentage breakage and capacity or shelling rate. To this end, the time taken to shell a known weight of egusi was measured. Random samples were withdrawn from the output of the appliance and the numbers of completely shelled, partially shelled, broken and unshelled

seeds in each sample were recorded. the appliance was tested at different speeds of the spinning disc. Egusi used in the tests was bought from the local market. One set of tests was on egusi at the usual market storage moisture content of about 6.5%. w.b. Also, as is commonly done to facilitate manual shelling, a batch of the egusi seeds was slightly wetted before it was used in another set of tests. The wetting raised the moisture content of the unshelled seeds to an average of 9% , w. b.

The aggregated results of these tests are presented in Table 1 giving mean values for replicated tests at each speed of the spinning disc and the overall means of seed counts in the replicated sample

Table 1: performance Test Data

Material	Shelling+ speed	W** (gm)	t (sec)	*N** 0	N* 1	N* 2	N* 3	N* 4
Egusi seeds at market storage moisture content of about 6.5% w.b.	Whip	132	45	220	130	80	10	21
	Stir	107	40	194	147	41	6	24
	Puree	106	35	251	219	30	2	36
	Beat	83	29	213	210	3	0	37
	Aerate	115	42	176	174	2	0	39
	Crumb	120	45	235	233	2	0	62
	Chop	132	47	242	239	3	0	71
Wetted egusi at average moisture content of 9.2% w.b.	Whip	165	57	148	99	44	5	7
	Stir	116	43	144	129	11	4	9
	Puree	121	39	207	205	1	1	16
	Beat	145	54	183	182	1	0	18
	Aerate	121	41	247	245	2	0	31
	Crumb	137	54	138	138	0	0	21
	Chop	147	52	227	224	2	1	40

\+ shelling speed designated by indicated blender speed.
**w is weight of egusi seeds shelled in time t.
*N_0 = means total number of seeds in sample = ($N_1 + N_2 + N_3$)
N_1 = means number of wholly shelled seeds in sample
N_2 = means number of partially shelled seeds in sample
N_3 = means number of unshelled seeds in sample
N_4 = means number of broken shelled seeds in sample

4.1 PERFORMANCE EVALUATION

On the basis of the data given in table 1, the capacity of the egusi shelling appliance was determined as W/t in kg/h. the effectiveness of shelling was variously estimated as N_1/N_0, N_2/N_0, N_3/N_0 and N_4/N_0. $N_0 - N_4$ are as defined in Table 1. The results of these computations are presented in Table 2 as performance indices for the appliance.

Table 2 shows that as the speed of the spinning disc increased, the percentage of wholly shelled seeds and the percentage breakage increased while percentages of partially shelled and unshelled seeds

decreased. The wetted seeds had lower percentage breakage and higher percentage of wholly shelled seeds at all shelling speeds. This maybe explained by the fact that slight wetting of already dry egusi tends to puff up the shell thereby freeing the cotyledon from the shell. This explanation is supported by the observation that, while the major and intermediate diameters differed little, if at al, in wetted and unwetted unshelled egusi seeds, the minor diameter showed considerable increase in the wetted seeds [4].

Beyond the "beat" speed, practically no seeds emerged unshelled and the percentage of partially shelled seeds decreased to 1.41 and 0.55 for the unwetted and wetted egusi respectively. The

Table 2: Performance indices of Appliance*

Material	Shelling speed	Capacity Wit (kg/h)	N_1/N_O (%)	N_2/N_O (%)	N_3/N_C (%)	N_4/N_O (%)
Egusi seeds at market storage moisture content of about 6.5% W.b.	Whip	10.56	59.09	36.36	4.55	9.55
	Stir	9.63	75.77	21.13	3.09	12.37
	Puree	10.90	87.25	11.95	0.80	14.34
	Beat	10.30	98.59	1.41	0	17.37
	Aerate	9.86	98.86	1.14	0	22.16
	Crumb	9.60	99.15	0.86	0	26.38
	Chop	10.11	98.76	1.24	0	29.34
Wetted egusi at average moisture content of 9.2% w.b.	Whip	10.42	66.89	29.73	3.38	4.73
	Stir	9.71	89.58	7.64	2.78	6.25
	Puree	11.17	99.03	0.48	0.48	7.73
	Beat	9.67	99.45	0.55	0	9.84
	Aerate	10.62	99.19	0.81	0	12.55
	Crumb	9.13	100.00	0	0	15.22
	Chop	10.18	98.68	0.88	0.44	17.62

*Letter symbols are as defined in Table 1
N_1/N_0 = fraction of wholly shelled seeds
N_2/N_0=fraction of partially shelled seeds
N_3/N_0 = fraction of unshelled seeds
N_4/N_0 = fraction of broken seeds

Shelling rate appeared to be independent of the speed being an average of 10 kg/h. the dependence of the various indices shelling effectiveness on speed of spinning disc is illustrated in Fig. 5. For almost all home applications egusi is usually ground or otherwise

comminuted before use. Therefore, within limits, breakage will not constitute an important performance defect of the appliance, especially if the egusi is shelled just before use. Breakage is considered to be within limits if it does not lead to pulverization or production of fines too small for easy collection without losses. It is preferable to achieve complete shelling that precludes subsequent manual sorting and shelling even at the expense of increased breakage. At any rate, it is recommended to shell the egusi just before use because mechanical damage to shelled egusi seeds predisposes them to deterioration by rancidification or mould growth if stored for some time before use. The level of breakage recorded for the appliance was not excessive. A minimum percentage breakage of about 8% compatible

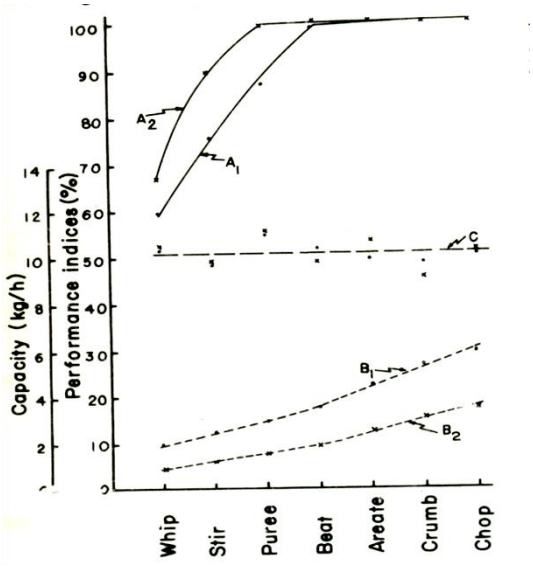

Fig. 5: Dependence of sheller performance on shelling speed.

A – percentage of wholly shelled seeds; B – percentage breakage (subscripts 1and 2 denote un-wetted and wetted seeds resp.); C – mean Sheller capacity with complete shelling was recorded for the wetted egusi seeds.

As an overall evaluation, the prototype egusi shelling kitchen appliance performed satisfactorily. It can shell the quantity of egusi that would otherwise at least 2h in under three minutes.

5. CONCLUSION

The prototype egusi shelling appliance performs quite satisfactorily.

For the unwetted egusi seeds , the best shelling performance is achieved at blender "beat" speed with nearly complete shelling effectiveness and 17% breakage at a capacity of about 10 kg/h.

Since the egusi may be shelled just before use, breakage is not a serious performance defect. Using wetted egusi the optimum shelling speed is at blender "puree" speed. It is recommended o slightly wet the egusi before shelling especially if it is desired to keep the percentage breakage down to the achievable minimum of about 8%.

The small size and light weight make the appliance suitable as a kitchen appliance. It may be fitted to a kitchen electric blender for use thus making the appliance a convenient and inexpensive accessory to the kitchen blender.

REFERENCES

1. F.A.O., 1968, Food Composition Tables for use in Africa, F.A.O. Nutrition Division, Rome.
2. MAKANJUOLA, G.A., 1972, a Study of some of the physical properties of melon seeds, J. Agric. Eng'g. Res. 19 (1), pp.128-137.
3. OYENUGA, V.A., 1968, Nigeria's food and feeding stuff, Ibadan University Press, Ibadan, Nigeria.
4. ODIGBOH, E.U., 1977, A spinning disc "melon" seeds shelling machine: development, design and prototype construction, Accepted for publication in Transactions of ASAE, Ms No. PM – 220.