Challenges of designing a cracker for Morama bean – Short communication

Z. Tjiparuro

Rural Industries Promotions Company Botswana, Kanye, Botswana

Abstract

Tjiparuro Z., 2013. **Challenges of designing a cracker for Morama bean – Short communication**. Res. Agr. Eng., *59*: 35–37.

Experiments were done on Morama beans (*Tylosema esculentum*) using macadamia nut crackers. Results and subsequent design work done thereafter showed that the cracking of the beans, their alignment during cracking and separation of kernels from shells presented peculiar challenges unresolvable by conventional processes.

Keywords: *Tylosema esculentum*; gemsbok bean; separation methods; agricultural machines

What is scientifically known as *Tylosema esculentum* and classified as a bean is essentially, especially to a layperson, a hard-shelled nut known as Morama in the Botswana vernacular, where it is abundant. It is also abundant in Eastern Namibia, with traces in South Africa (Nepolo et al. 2009). Morama is a source of quality protein, oil rich in mono and di-unsaturated fatty acids, with no cholesterol, from which a range of products such as milk, oil, cookies, yoghurt, etc. can be derived (Jackson et al. 2010; Holse et al. 2011). Traditionally, the bean is usually roasted and manually cracked along its major axis to split into two clean halves. Shells are separated from kernels by hand sorting. Jideani et al. (2009) studied its physical parameters. The bean's anecdotal parameters acknowledged to influence the design of processing equipment (Olmstead 1975; Yoshimura, Papalambros 2004), however, were not studied.

MATERIAL AND METHODS

In April 2007, experiments were done on Morama beans in Tzaneen (South Africa) using macadamia nuts crackers. The beans were divided into two almost equal batches, cracked on two machines, and the resulting mixtures were put through sieves of sizes 14, 12, 7 and 3 mm. From this the following main parameters were computed.

Size distribution (%): the ratio in weight of the beans captured by each screen to the total weight of the throughput from the machine

Cracking efficiency (%): the ratio of completely cracked beans to the total beans fed into the hopper.

Kernel breakage ratio (KBR): the amount of damaged and cracked kernel

RESULTS AND DISCUSSION

The results are given in Table 1 and their histograms are given in Fig. 1. The results show the following:

14 mm sieve: 59.5 % and 67.8% of beans were trapped by 14 mm sieve, dominated by 90% and 88.2% non-cracks, as a result of the smaller size of Morama beans compared to macadamia nuts, respectively (Naturland 2000; Jideani et al. 2009). Additionally, a lot of beans were partially cracked and thus unable to release the kernels.

Table 1. Size distribution, cracking efficiency and kernel breakage ratio

Cracker type	Parameters		Sieve size (mm)/quantity (%)				
			14	12	7	3	< 3
Motorised Cracker	SD	–	59.5	14.4	18.4	5.5	2.2
	CE	46.0					
	KBR	14.3					
Commercial Cracker Type 1	SD	–	67.8	13.3	12.6	4.0	2.2
	CE	40.0					
	KBR	12.9					

SD – size distribution, CE – cracking efficiency, KBR – kernel breakage ratio

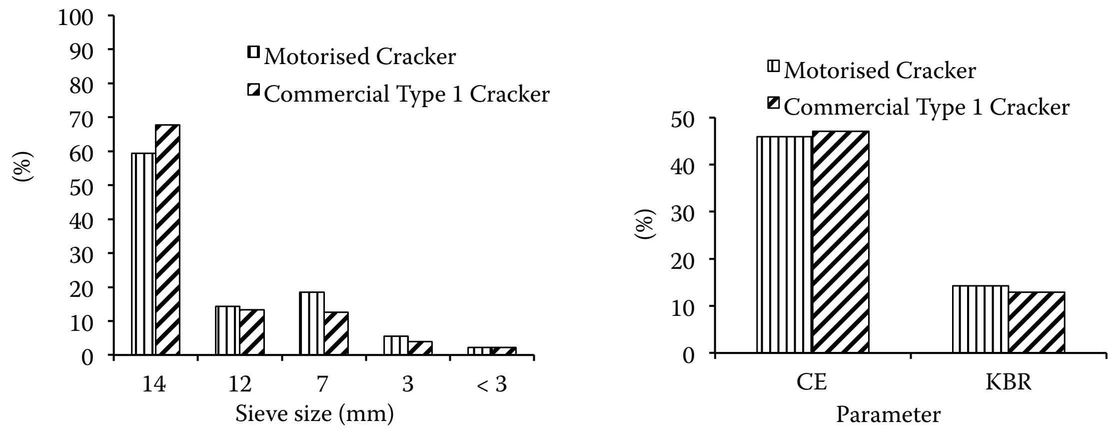

Fig. 1. Size distribution, cracking efficiency (CE) and kernel breakage ratio (KBR)

12 mm sieve: All beans in this category were cracked and consisted mostly of halves and quarters in almost equal proportion.

7 mm sieve: This consists mostly of quarters of kernels and shells, exhibiting 100% cracking rate.

3 mm sieve and below: Anything at 3 mm sieve size and below consisted mostly of small cracks and dust of kernels and shells, certainly the kind that will be blown away as waste or dust in a commercial operation. However at 7.5% and 6.2% for both crackers, respectively, pulverisation of the beans was not very excessive.

Overall, the Macadamia crackers were not suitable for Morama beans with less than 46.0% cracking efficiency for both machines. Thus a suitable machine was developed. During its testing, two challenges namely, bean alignment and bean shell-lightening, were found to be central to the design of a Morama processing plant.

Bean alignment during cracking. The beans present a design challenge as naturally they rest on their shorter axes, hence need careful alignment to present their major axis during cracking.

Separation by shell-lightening. Morama shells and kernels are difficult to separate as they both sink in water and do not separate in air. Thus, shell-weighting was tried by soaking the beans in water at intervals of 10, 30, 60 and 120 min to enable just the shells to absorb water and become heavier, but could not separate when cracked and passed through a draft of air. Lastly, shell-lightening was done by rubbing off the weight of shells with carborundum stones before cracking. This resulted in shells separating to leave behind a mixture dominated by kernels.

CONCLUSIONS

In conclusion, the Macadamia crackers were not suitable for the beans. Alignment of the bean during cracking was found to be a key parameter. Lastly, an approach to deal with crops whose difference between shells and kernels is very minimal is presented.

References

Holse M., Larsen F.H., Hansen Å., Engelsen S.B., 2011. Characterization of marama bean (*Tylosema esculentum*) by comparative spectroscopy: NMR, FT-Raman, FT-IR and NIR. Food Research International, *44*: 373–384.

Jackson J. C., Duodu K.G., Holse M, de Faria M.D., Jordaan D., Chingwaru W., Hansen A., Cencic A., Kandawa-Schultz M., Mpotokwane S.M., Chimwamurombe P., de Kock H L., Minnaar A., 2010. The morama bean (*Tylosema esculentum*): a potential crop for Southern Africa. Advanced in Food and Nutrition Research, *61*: 187–246.

Jidean V.A., Van Wyk J., Cruywagen M.H., 2009. Physical properties of *Tylosema esculentum* and the effect of roasting on the functional properties of its flour. African Journal of Agricultural Research, *4*: 1208–1219.

Naturland, 2000. Organic Farming in the Tropics and Subtropics Exemplary Description of 20 Crops. Available at http://www.naturland.de/fileadmin/MDB/documents/Publication/English/macadamia.pdf (accessed November 08, 2011).

Nepolo E., Takundwa M., Chimwamurombe P.M., Cullis C. A., Kunert K., 2009. A review of geographical distribution of marama bean (*Tylosema esculentum* (Burchell) Schreiber) and genetic diversity in the Namibian germplasm. African Journal of Biotechnology, *8*: 2088–2093.

Olmstead A.L., 1975. The mechanization of reaping and mowing in American agriculture, 1833–1870. The Journal of Economic History, *35*: 327–352.

Yoshimura M., Papalambros P.Y., 2004. Kansei Engineering in Concurrent Product Design: a Progress Review. In: Proceedings of the Tools and Methods of Competitive Engineering Conference, April 13–17, 2004, Lausanne, Switzerland: 177–186.

Received for publication November 15, 2011
Accepted after corrections July 13, 2012

Corresponding author:

Dr. Zeundjua Tjiparuro, Rural Industries Promotions Company, GoTsong Ward, Kanye, Botswana
phone: + 267 7140 4533, fax: + 267 5440 642, e-mail: zeundjua.tjiparuro@gmail.com