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Shelling studies for steam treated cashewnuts using an automatic cashew sheller

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ABSTRACT : The economic interest has made many countries of the world to encourage the cultivation of cashew and it is fast becoming an export produce in many developing countries. The necessary processing operations needed for cashewnut before obtaining the standard exportable quality of edible cashew kernel require lot of time, materials and human resources. This study considers the shelling capacity, shelling efficiency, shelling percentage, broken kernel percentage and wholeness of kernels obtainable by varying the steaming pressure (0.0, 1.0, 1.5, 2.0 and 2.5 $kgcm^{-2}$) and steaming duration (15, 20, 25, 30 and 35 min). The cashewnuts were steamed in steam cooker and kept in ambient temperature for 20 to 24h for tempering. The dried nuts were shelled using automatic cashew sheller. The automatic cashewnut sheller recorded maximum shelling capacity (18.40 kg per hour), shelling efficiency (80.66 %), shelling percentage (31.74 %), whole kernel recovery (85.47 %) and broken kernel percentage (14.53 %), respectively at 0.0 kg / cm^2 for 30 min.

KEY WORDS : Automatic cashew sheller, Cashewnuts, Pretreatment, Shelling parameters

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The cashew tree is evergreen tropical tree. The main commercial product of the cashew tree is the nut. The cashew fruit is unusual in comparison with other tree nuts since the nut is outside the fruit. The cashew apple is an edible false fruit, attached to the externally born nut by a stem. In its raw state, the shell of the nut is leathery, not brittle. It contains the thick vesicant oil, CSNL, with in a sponge-like interior. A thin testa skin surrounds the kernel and keeps it separate from the inside of the shell. The primary products of the cashewnuts are the kernels which have value as confectionery nuts. Cashewnut shell liquid (CNSL) is an important industrial raw material for resin manufacture and the shells can be burned to provide heat for the pre treatment operation.

The effects of heat treatment on the behaviour of some agricultural materials during handling and processing have been studied by other researchers. Processing raw cashewnuts into kernel is generally a time consuming and labour intensive operation, involving heat treatment of the nuts, shelling, peeling, grading and packaging; however, shelling has presented the greatest processing problem. This is due to the peculiar kidney-shape of the nut, the presence of a tough, leathery outer shell and the corrosive cashewnut shell liquid it contains (Ohler, 1979; Jain and Kumar, 1997).

Considering that most research works by Oloso and Clarke (1993); Ajav (1996); Balasubramanian (2007); Akinoso *et al.* (2004) and Ojolo and Ogunsina (2007) were carried out on roasted nuts, alternative method of kernels production must be explored. This informs the use of steam roasting in this research work.

METHODOLOGY

Fully matured, good quality Ivory Coast origin cashewnuts (6.5% w.b. moisture content) were procured from M/s Kalbhavi Cashews Industries, Mangalore for conducting the experiments.

Pretreatment of raw cashewnuts for shelling test:

The raw cashewnuts were pre-treated by steaming in a steam cooker at different pressures (0.0, 1.0, 1.5, 2.0 and 2.5 kg/cm^2) for different steaming durations (15, 20, 25, 30 and 35 min). The steam roasting process, commonly known as "cooking process" consists of a baby boiler with a steam cooker where the cashewnuts were cooked. The different

steaming pressures and steaming durations were based on preliminary trails. The traditional wisdom of cashewnut processors were neither over-cooking of nuts (CNSL oozes out) nor under-cooking the nut (hard when pressed). After the steam treatment, the treated cashewnuts were weighed and then kept in an ambient environment for 20 to 24h for tempering. Later the pretreated nuts were deshelled using automatic cashewnut sheller.

Baby boiler :

The baby boiler is a manually loaded fire tube boiler, which produces steam at 5.0 – 6.0 kg/cm^2. It has four vertical tubes at the bottom fixed to the base. Water is stored at the bottom which is heated by the liquid petroleum gas. The heat is transferred from the tubes to the water for generation of steam.

Cashewnut cooker :

A cylindrical steam cooker, which has provisions for feeding of the cashewnuts at the top and discharging of cooked nuts from the side near bottom, has a holding capacity of 60 kg of cashewnuts per batch. After the loading of cashewnuts, steam from the boiler is introduced into the cooker, with a manually controlled valve at pre-determined pressures for specified durations. For zero pressure the outlet is not closed tightly to escape steam from the cooker. A provision has been made at the bottom of the cooker to collect the condensed steam in the form of water and it is removed through a water discharge outlet. The cooked cashewnuts are removed from the outlet and spread on the floor for conditioning. The cooked nuts were shelled using an automatic cashew sheller.

Treatment details :

Independent variable:

Steam pressures (kg/cm^2): 5 levels (P_1=0.0; P_2=1.0; P_3=1.5; P_4=2.0 and P_5=2.5).

Steaming duration (min: 5 levels (T_1=15; T_2=20; T_3=25; T_4=30 and t_5=35).

Number of machines: 1

Number of replications: 3

Design – Factorial CRD (3 factors)

Testing of automatic cashewnut sheller:

The automatic cashewnut sheller used for the present study was tested as per the standard procedures for combination of various treatments as described earlier. During each trial, 4 kg of steam cooked nuts were taken. Before the test was started, the sheller was carefully checked for the smooth operation. Then, the cashewnuts were shelled at one side of the automatic cashew sheller. A stopwatch was used to record the exact shelling time taken to shell 4 kg steam cooked nuts in sheller. The output of the sheller was manually separated into various fractions as: unshelled nut, whole kernel, broken kernel and shells, in order to compute the shelling capacity, shelling efficiency, whole kernel recovery and broken kernel percentage. The procedure was repeated for all the combinations of treatments and data were recorded. The following parameters were recorded during testing: Mass of nuts fed through the feeding section (kg), mass of whole kernels after shelling (kg), mass of broken kernels (kg), mass of un-shelled cashewnuts (kg), mass of shells (kg) and time of operation (h).

Shelling capacity :

The shelling capacity of the cashewnut sheller was calculated as:

$$\text{Shelling capacity (kg/h)} = \frac{\text{Total quality of shelled nuts (kg)}}{\text{Time required for shelling (h)}}$$

Shelling efficiency :

$$\text{Shelling efficiency (\%)} = \frac{\text{Weight of shelled nuts (kg)}}{\text{Weight of cahsew nuts fed for shelling (kg)}} \text{ x } 100$$

Shelling percentage:

$$\text{Shelling percentage (\%)} = \frac{\text{Weight of cashew kernels (kg)}}{\text{Weight of shelled nuts (h)}} \text{ x } 100$$

Whole kernel recovery :

$$\text{Whole Kerenls (\%)} = \frac{\text{Weight of whole cashew kernels obtained (kg)}}{\text{Total weight of shelled cashew kernels (kg)}} \text{ x } 100$$

Broken kernel percentage :

$$\text{Broken (\%)} = \frac{\text{Weight of broken kernels obtained (kg)}}{\text{Total weight of shelled cashew kernels (kg)}} \text{ x } 100$$

RESULTS AND DISCUSSION

The results of the present study as well as relevant discussions have been presented under following sub heads:

Shelling capacity :

From the Table1, it was reported that the shelling capacity values obtained in the range of 15.46 to 18.40 kg/h. The mean shelling capacity of ungraded nuts was significantly higher (18.40 kg/h) at 0.0 kg/cm^2 for 30 minutes steam duration as compared to other treatments. The lower shelling capacity (15.46 kg/h) was recorded in the treatment P_2T_4, the maximum (18.40 kg/h) shelling capacity was observed in the treatment P_1T_4. Hence, the pre-treatment with lower steam pressure and optimum steam duration was found to considerably increase the shelling capacity of ungraded nuts under automatic sheller.

Shelling efficiency :

From the Table1, the shelling efficiency of automatic cashew sheller was obtained in the range of 62.96 to 80.66 per cent. The mean shelling efficiency of ungraded nuts was significantly higher (80.66 %) at 0.0 kg/cm^2 for 30 minutes steam duration as compared to other treatments. The lower shelling efficiency (62.96 %) was recorded in the treatment P_2T_5 and the higher (80.66 %) was observed in the treatment P_2T_5. Hence, the pre-treatment with lower steam pressure and longer steam duration was found to considerably increase the shelling efficiency of automatic sheller.

Shelling percentage:

From the Table1, the shelling percentage of automatic cashew sheller was obtained in the range of 27.89 to 31.74 per cent. The mean shelling percentage of ungraded nuts was significantly higher (31.74 %) at 0.0 kg/cm^2 for 30 minutes steam duration as compared to other treatments. The lower shelling percentage (27.89 %) was recorded in the treatment P_1T_2 and the higher (31.74 %) was observed in the treatment P_1T_4. Hence, the pre-treatment with lower steam pressure and longer steam duration was found to considerably increase the shelling percentage of automatic sheller.

Whole kernel recovery:

From the Table1, the whole kernel recovery of automatic cashew sheller was recorded in the range of 27.68 to 85.47 per cent. The mean whole kernel recovery of ungraded nuts was significantly higher (85.47 %) at 0.0 kg/cm^2 for 30 minutes steam duration as compared to other treatments. The minimum whole kernel recovery (27.68 %) was recorded in the treatment P_2T_2 and the maximum (85.47 %) was observed in the treatment P_1T_4. Hence, the pre-treatment with lower steam pressure and longer steam duration was found to considerably increase the whole kernel recovery of automatic sheller under medium nuts.

Table 1 : Shelling parameters of pre treated cashew nuts

Pretreatments	Ungraded nuts				
	Shelling capacity (kg/h)	Shelling efficiency (%)	Shelling percentage (%)	Whole kernel recovery (%)	Kernel breakage (%)
P_1T_1	17.30	76.50	29.06	55.33	44.66
P_1T_2	15.96	77.38	27.89	72.69	27.30
P_1T_3	18.26	71.50	28.09	66.77	33.22
P_1T_4	18.40	80.66	31.74	85.47	14.53
P_1T_5	16.96	77.16	29.93	82.28	17.71
P_2T_1	18.02	64.53	31.55	34.04	65.90
P_2T_2	16.98	72.91	31.60	27.68	72.31
P_2T_3	15.62	70.20	31.61	41.38	58.61
P_2T_4	15.46	71.91	31.28	35.12	64.87
P_2T_5	18.38	62.96	31.48	52.36	47.63
P_3T_1	17.18	74.50	30.41	48.42	51.57
P_3T_2	16.50	72.03	30.18	44.27	55.72
P_3T_3	17.12	77.33	28.87	47.76	52.24
P_3T_4	16.44	80.65	30.16	50.55	49.44
P_3T_5	17.20	69.83	29.84	44.83	55.16
P_4T_1	15.92	75.33	30.11	50.07	49.93
P_4T_2	16.08	76.66	31.68	50.90	49.10
P_4T_3	16.04	68.00	27.91	66.97	33.03
P_4T_4	16.18	64.33	31.12	85.45	14.55
P_4T_5	16.36	76.00	31.73	65.79	34.21
P_5T_1	17.60	66.30	29.98	62.87	37.12
P_5T_2	17.10	63.10	29.94	73.19	26.80
P_5T_3	16.78	74.15	30.67	68.16	31.84
P_5T_4	17.22	72.26	30.14	71.39	28.60
P_5T_5	17.22	69.06	29.29	73.75	26.24

Steaming pressure: P_1 - 0.0 kg/cm^2; P_2 - 1.0 kg/cm^2; P_3 - 1.5 kg/cm^2; P_4 - 2.0 kg/cm^2 and P_5 - 2.5 kg/cm^2
Steaming duration: T_1 - 15 min; T_2 - 20 min; T_3 - 25 min; T_4 -30 min; and T_5 - 35 min

Broken kernel percentage:

From the Table1, the broken kernel percentage was reported in the range of 14.53 per cent to 72.31 per cent. The mean kernel breakage of automatic cashew sheller was significantly lower (14.53%) at 0.0 kg/cm^2 for 30 minutes steam duration as compared to other treatments. The minimum kernel breakage (14.53%) was observed in the treatment P_1T_4 and the maximum breakage was reported in the treatment P_2T_2. Further, the pre-treatment with lower steam pressure and higher steam duration was found to be considerably reducing the kernel breakage of automatic cashew sheller under ungraded nuts.

Conclusion:

However, shelling capacity, shelling efficiency and whole kernel recovery was higher in the treatment P_1T_4 (0.0 kg/cm^2 for 30 min). It is concluded that, lower pressure and longer steam duration gave maximum shelling capacity, shelling efficiency and whole kernel recovery and minimum broken kernel percentage.

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REFERENCES

Ajav, E.A. (1996). The design and testing of a low cost cashewnut cracker for peasant farmers. *Trop. Agric.*, **73** (3) : 180-186.

Akinoso, R., Asiru, W.B. and Awoliyi, O.O. (2004). Development of a cashewnut roasting device. *Nigerian Food J.*, **6**(3): 67 - 95.

Balasubramaniam, D. (2006). Improving whole kernel recovery in cashewnut processing specific to Nigeria nuts. *Agricultural Mechanization in Asia, Africa & Latin America*, **37**(1): 58-64.

Balasubramaniam, D. (2007). Optimization of processing parameters using farm level cashewnut processing. *J. Agric. Engg. Today*, **31** (2) : 35-41.

Dandekar, S.R. and Salvi, D.A. (2003). Standardisation of steam roasting parameters of cashewnut processing. B. Tech. (Agril. Engg.) Thesis, Dr. Balasaheb Sawant Kokan Krishi Vidyapeeth, Dapoli, M.S. (INDIA).

Intermediate Technology Development Group (ITDG) (2005). Technical brief: cashewnut processing knowledge and information services. Schumacher Center for Technology and Development. Bourton on Dunsore, Rugby, Warwickshire. CV 239Q UK.

Jain, R.K. and Kumar, S. (1997). Development of cashewnut sheller. *J. Food Engg.*, **32** (3) : 339-345.

Ogunsina, B.S. and Bamgboye, A.I. (2007). Effects of pre-shelling treatment on the physical properties of cashewnut (*Anacardium occidentale*). *Internat. Agrophysics*, **21** : 385-389.

Ohler, J.G. (1979). *Cashew growing: Tropical Abstracts*; Cashew Department of Agricultural Research, Royal Tropical Institute: Amsterdam. pp. 16–19.

Ojolo, S.J. and Ogunsina, B.S. (2007). Development of a cashewnut cracking device. Agricultural Engineering International. *The CIGR Ejournal*. Vol. IX. Manuscript PM 06 030 June. International Commission of Agricultural Engineering. USA.

Oloso, A.O. and Clarke, B. (1993). Some aspects of strength properties of cashewnut. *J. Agric. Engg. Res.*, **55** (1) : 27-43.