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Studies on the effect of Moisture Content, Nut Size Distribution, Steam Exposure Time on the Whole Kernel out Turn of Cashew

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ABSTRACT

This paper investigates the effect of moisture content, nut size distribution and steam exposure time on the Whole kernel out turn (WKO) of cashew nuts. This paper is divided into two parts. First part deals with the brief details of cashew nut, which includes (i) present status of cashew production in India and abroad (ii) Propagation and production of planting material, (iii) economic aspects of cashew (iv)various constraints in cashew nut production. The second part deals with the experimental investigation on the effect of moisture content (MC), nut size distribution, steam exposure time (SET) on Whole kernel out turn (WKO) of cashew nuts during shelling. Three nut sizes of size varying from about 20 mm to 40mm, six levels of MC (7.6%, 9.5%, 11.6%, 12.4%, 14.8%, 16.1% and 17.9% (wet basis) and five levels of SET were considered for the experimental study. Nuts were steam boiled at 750 kPa. From the studies, it is generally observed that the WKO values are decreasing with the increase of moisture content. It is further felt that the studies can be extended with the combination of MC and SET to consolidate the WKO results.

KEY WORDS: Moisture content, nuts, steam exposure time.

1. INTRODUCTION

Cashew is a very highly nutritious and compact form of food, offers a significant amount of energy. Cashew nut refers to the ash-green or greyish-brown kidney-shaped seed at the base of cashew apple. It weighs between 4–6 g and measures about 24 mm length, 22 mm width and 17mm thickness (Agnoloni and Giuliani, 1977; Oloso and Clarke, 1993; Balasubramanian, 2001; 2006; Ogunsina and Bamgboye, 2007). Fig.1, shows the typical internal structure of a cashew nut featuring the kernel, the testa and the shell. The important part is the kernel, an edible portion which is widely eaten as a snack-food for accompanying drinks at cocktails or an ingredient for confectioneries and bakery products. From Fig. 1, it can be noted that the testa shields the kernel and separates it from the shell inside the internal cavity where the kernel develops. The shell is a layer of three protective tissues namely: the epicarp, the external integument of the nut; the mesocarp, which contains cashew nut shell liquid and the endocarp, which limits the internal cavity or porosity. In general, cashew nut has very good taste and flavor and can be eaten in various forms such as raw, fried, salted, sweetened with sugar and in variety of combinations. The nut contains an acrid compound and the cashew nut shell contains about 20% of reddish brown oil, popularly known as Cashew Nut Shell Liquid (CNSL), a by-product of the roasting process.

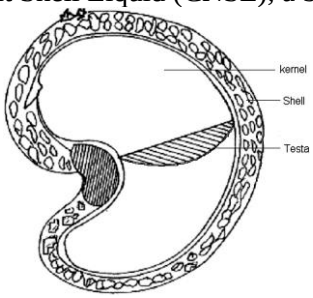

Figure.1.Typical longitudinally section of cashew nut

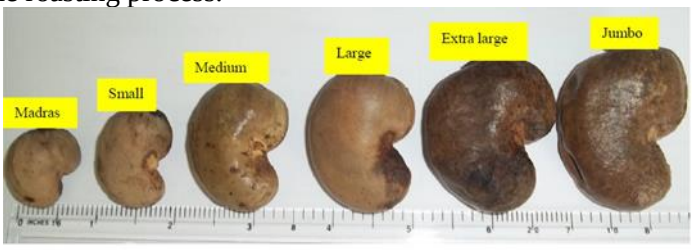

Plate 1. Different sizes of cashew nuts. Source: Adeigbe, 2013 Unpublished.

Figure.2. Different sizes of cashew nuts

Cashew nut finds its applications in numerous forms. Typical applications include, the high-oleic-acid in cashew kernel oil, cashew nut frying oil, fruit polish, vegetable-based lubricant, feedstock (Holland, 1991; Janick and Paull, 2008). Andrighetti (1994) mentioned that the tannin content of the seed coat is a useful resource in the leather manufacturing industry. Resin extracts from cashew nut shell liquid is a valuable material for manufacturing (i) acid-resistant paints, (ii) inks, (iii) varnishes, (iv) insecticides, (v) fungicides, (vi) lacquers for decorating vases and (vii) friction powder for automobile brake linings and clutch discs (Laurens, 1997; Panda and Panda, 1991 and Echendu, 1995). The conversion of processed cashew nut shells into alternative fuels by pyrolysis has also been reported (Ogunsina, 2009). Table.1 highlights the Area, production and productivity of cashew in India during the period 1965-1996.

Table.1. Area, Production and Productivity in India

State	Area (ha)	National % Area	Production (tons)	National % % Prod.	Productivity (kg/ha)
Kerala	118, 600	18.6	140, 000	33.5	1, 180
Karnataka	83, 900	13.2	37, 600	8.9	448
Goa	49, 600	7.8	17, 800	4.3	359
Maharashtra	66, 700	10.5	69, 000	16.5	1, 034
Tamil Nadu	77, 360	12.2	30, 930	7.4	400
Andhra Pradesh	118, 080	18.6	71, 700	17.2	607
Orissa	101, 850	16.0	43, 000	10.3	422
West Bengal	8, 680	1.4	6, 960	1.7	802
Others	10, 200	1.6	840	0.2	82
Total	**634, 970**	**100.0**	**417, 830**	**100.0**	**658**

Table.2. Cashew cultivars recommended for different states of India

State	Cultivars Recommended	Progeny
Karnataka	Selection 1	VTH-107/3
	Selection 2	VTH-40/1
	Ullal 1	8/46 Taliparamba
	Ullal 2	3/86 Guntur
	Ullal 3	5/37 Manjeri
	Ullal 4	2/77 Tni Andhra
	UN 50	2/77 Nileshwar
	VRI 1	M-10/4
	VRI 2	M-44/3
	Vengurla 1	Ansur-1
	Vengurla 4	Mid Red X Vetore 56
	Chintamani 1	8/46 Taliparamba
Kerala	Madakkathara 1	BLA-39-1
	Madakkathara 2	NDR 2-1
	K-22-1	22 Kottarakkara
	Dhana	ALGD-1- x K 30-1
	Priyanka	BLA-139-1 x k 30-1
Maharashra and Goa	Vengurla-1	Ansur-1
	Vengurla-4	Mid Red x Vetore-56
	Vengurla-6	Vetore 56 x Ansur-1
Tamil Nadu	VRI-1	M 10/4
	VRI-2	M 44/3
	VRI-3	M 26/2
Andhra Pradesh	BPP-4	EPM 9/8
	BPP-6	T No 56
	BPP-8	T No. 1x T No. 39
	VRI-2	M 44/3
Orissa	VRI-2	M 44/3
	Bhubaneshvar-1	Vengurla 36/3
West Bengal	Jhargram-1	T No 16 of Bapatla
Madhya Pradesh	T No 40	
	Vengurla 4	Mid Red x Vetore-56

The following techniques or means are important in nursing young grafted plants.

- Grafts need to be watered frequently based on the season.
- Excess water is to be drained
- Shoots on the rootstocks have to be nipped off frequently.
- Polythene wrapping at the union has to be removed about three or four months after grafting to prevent girdling.
- When the scion leaves turn from brown to green, rootstock leaves have to be removed
- Flower shoots that sprout during the normal flowering season should be removed at the nursery stage.
- To prevent roots penetrating into the ground, grafted plants proper precautions should be taken
- Partial shade has to be provided to avoid sun-scorch by placing the grafted plants in a lath/screen house.
- Regular insecticide sprays need to be given to control leaf sucking insects.
- When transporting grafted plants, care should be taken to protect terminal shoots and taproots

Table.3. Production of cashew nut by top world cashew nut producers

Production in Metric tones						
Contry	**2010**		**2011**		**2012**	
	FAOSTAT	**ACA**	**FAOSTAT**	**ACA**	**FAOSTAT**	**RRF**
India	613000	465000	647600	400000	680000	554000
Cote d'lvoire	380000	335000	452656	385000	450000	380000
Vietnam	1242000	300000	1272000	360000	1190900	280000
Brazil	104342	300000	230785	230000	80630	265000
Guinea-Bissau	91100	135000	128687	190000	130000	160000
Tanzania	80000	9000	75000	110000	122274	120000
Nigeria	682524	70000	813023	90000	836500	85000
Benin	69700	85000	70000	90000	170000	85000
Mozambique	67200	65000	72263	80000	64731	70000
Indonesia	145082	90000	122100	80000	117400	125000

Source: FAOSTAT (FAO Statistics, 2013); ACA (Africa Cashew Alliance 2012 reports); RRF (Red River Foods Inc., 2012 production estimates).

Table.4. Uses of cashew nut

Cashew parts	**Products**	**Uses**	**Medicinal importance**	**Source**
Cashew tree	Leaves and stem back	For making local	Bactericidal, germicidal and herbal health benefit, stop diarrhea, dry secretion, increase the libido, reduce fever, blood sugar and pressure.	Olife (2013), Dahake (2009), Masaki (1999)
Cashew stem and branches	Wood/ Timber	Furniture, fishing boats and ship rollers (highly resistant to termite attack)		Chipojola (2009)
Cashew stem	Ink and Vanishes	Indelible ink for marking and printing lines and cottons		
	Glues	Adhesive for woodwork panels, plywood and bookbinding. Insecticidal properties which prevent insects eating new boxes and books		
	Apple concentrate	For making Juice, Juice concentrates, liquor, vinegar, jam and beverages.	Has higher vitamin C content than guava, mango and oranges (146.6-372.0 mg / 100g fresh apple juice)	Olife (2013)
Apple	Apple flesh	For making pickle, chutney and candied products		
	Pressed cake from apple	Used for cattle feed after drying		
	Cashew kernel	For making snacks, confectioneries, butter, milk	High in protein (21%), carbohydrate (22%), Oil, Vitamins (thiamine) and 47% fat (heart friendly monounsaturated fatty acid) also rich in manganese, potassium, copper, Iron, magnesium, zinc, selenium and zea-xanthin for preventing deficiency diseases and serving as antioxidants	Blomhoff (2006)

Cashew nut	Cashew nut kernel oil (CNKO)	Sweet edible oil		
	Pressed cake from CNK (pomase)	Human and animal feed		
Cashew nut shell	Cashew nut shell liquid (CNSL)	Has high proportion of phenolic compounds, Manufacture of vehicle break lining compounds, water proofing agents, preservative, paints, plastics, type writer rollers, oil and acid-proof cement, industrial floor tiles	Potent antimicrobial agent for treating scurvy, sores, warts, ring worm, psoriasis, leprosy, elephantiasis and corns.	Mc Conville (1997)
Cashew inflorescence	Sweet scented flower	Apiary development and honey production		ACA (2012)

Constraints in Cashew Nut Production Development:

Cultivation:

- Inferior germ plasm and inadequate planting material of recommended varieties.
- Lack of adequate knowledge on improved cultural and management practices.
- Changes in weather patterns, fire hazards and weed problems.
- Improper utilization of cashew orchards and losses due to poor post-harvest practices.

Institutional:

- Lack of price support system for cashew.
- Inferior linkages with other agricultural organizations, both locally and internationally.
- Low credit facilities for the processing industry.
- High cost of inputs.

Technical:

- No encouragement for strong research
- Less manpower extension staff to make programs effective.
- Very weak in transferring technology

Socio-Economic:

- Displacement of large number of cashew growers due to civil unrest.
- Large unemployment and less income of cashew farmers.
- Weak market and physical infra-structure including storage, processing and transport facilities.
- Poor farm-gate prices during harvesting season.

2. MATERIALS AND METHODS

Freshly harvested cashew nuts were obtained from Bapatla, Andhra Pradesh, India at moisture content of about 6.0%. Extraneous materials such as leaves, stones, immature and spoilt nuts were removed from the batch. The cashew nuts were categorized in three grades of different sizes with respect to their major axial dimensions.

The sizes are: Large: 30 – 39 mm; Medium: 25 – 28 mm; Small: 19 – 24 mm.

The distribution of above sizes is approximately as per the literature (Andrighetti, 1994).

The samples were placed on raised pallets for good ventilation until the time of use according to common practice in the industry.

The experiment was conducted on three nut sizes mentioned above i.e large, medium and small, six levels of MC, namely, 7.6%, 9.5%, 11.6%, 12.4%, 14.8%, 16.1% and 17.9% (wet basis) and five levels of steam exposure time. The steam exposure time is 26, 28, 30, 32 and 34 min. Figure.3 shows the typical Cashew nut process by steam boiling method.

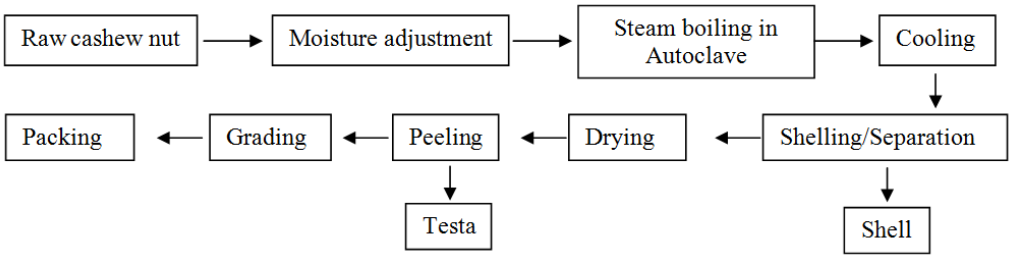

Figure.3. Typical production of cashew nut by steam boiling

The amount of water required for the samples to bring up to desired moisture content (MC) was estimated by using the following equation.

$$W_w = W_w \left(\frac{M_2 - M_1}{1 - M_1}\right) \quad (1)$$

Where, W_w = amount of water to be added; W_s = weight of sample for each MC to be adjusted; M_1 = Initial MC of sample; M_2 = final MC of sample.

After adjusting MC, all the samples were sealed in separate cellophane bags and allowed to equilibrate for four days at 4ºC. All MC estimations were carried out by ASAE procedures/standards (1998).

Estimation of Whole kernel out turn (WKO): All nuts were shelled using a hand-operated cashew nut shelling machine with the help of semi-skilled person (Ogunsina and Bamgboye, 2011; Kosoko, 2009; Balasubramanian, 2006 and Ajav, 1996). For each batch, whole kernels were separated and the weight was determined.

Whole kernel out turn was estimated as the percent ratio of the weight of the whole kernels (W_w) to the total weight of kernels recovered (W_r).

Weight of whole kernels (W_w) to the total weight of kernels recovered (W_r).

$$WKO = \frac{W_w}{W_T} X\ 100 \quad (2)$$

3. RESULTS AND DISCUSSION

Experiments were conducted systematically for all the samples. As mentioned earlier, WKO values are estimated for six MC conditions for small to large sized cashew nuts and for varying steam boiling. The consolidated results of WKO of cashew nuts that were pre-treated by steam-boiling is presented in Table 5. From Table 5, it can be observed that WKO decreased as MC increased within the range of experimental values. The reason could be due to an increase in the fracture resistance of the nut-shell as MC increased. The significant difference is observed for largest MC considered for the experiments. Further, it was observed that the shell was tough and after rupture, i.e it possesses brittle nature, it did not yield or split open to release the embedded kernel; exerting more force caused the total nutshell failure. From the Overall studies, it is observed that (i) the WKO values are generally decreasing with increase of MC (ii) Solid conclusion cannot be arrived at from the studies. To arrive at the optimum conditions for better yield, some more experiment are to be carried out in combination of MC and SET on various sizes of cashew nut. In the literature by Ogunsina (2010), mentioned that in their previous investigations with cashew nuts that were pre-treated by hot-oil roasting observed that the individual effect of pre-treatment method, nut size or MC alone cannot be used to determine WKO; rather, it is a product of interaction between these parameters.

Table.4. Whole kernel out turn of steam boiled cashew nuts

Steam exposure time (Minutes)	Nut sizes	Moisture content						
		7.6%	9.5%	11.6%	12.4%	14.8%	16.1%	17.9%
26	L	83.42	81.21	78.32	77.32	72.12	64.65	59.83
	M	87.43	83.43	79.43	76.32	71.25	65.21	56.34
	S	85.43	81.34	76.43	73.43	71.45	67.32	63.21
28	L	85.43	83.24	79.32	75.32	72.31	66.32	56.32
	M	79.43	74.87	71.65	65.32	61.24	59.82	53.43
	S	88.32	83.21	79.43	75.23	73.87	68.43	61.45
30	L	92.32	89.54	85.32	81.23	76.34	71.54	67.32
	M	89.45	87.65	83.45	80.45	78.21	74.21	65.43
	S	83.42	81.45	78.54	76.22	73.12	67.83	64.32
32	L	95.65	91.32	87.54	82.43	76.21	72.43	68.53
	M	87.98	84.65	80.65	76.53	72.54	68.21	61.26
	S	84.21	81.54	76.98	73.42	69.54	63.42	59.32
34	L	87.54	84.32	81.35	76.43	71.56	65.43	56.87
	M	84.76	81.54	78.36	73.65	69.87	63.87	54.54
	S	78.54	73.54	69.32	65.43	61.87	58.76	51.35

4. CONCLSION

Research and development activities should be strengthened to evolve appropriate technology on breeding, soil testing, disease and pest control, irrigation systems, fertilizer management and post-harvest technology. This paper investigates the effect of moisture content, nut size distribution and steam exposure time on the Whole kernel out turn (WKO) of cashew nuts. Three nut sizes of size varying from about 20 mm to 40mm, six levels of MC (7.6%, 9.5%, 11.6%, 12.4%, 14.8%, 16.1% and 17.9% (wet basis) and five levels of SET were considered for the experimental study. Nuts were steam boiled at 750 kPa. From the studies, it is observed that (i) the WKO values are generally decreasing with increase of MC (ii) Solid conclusion cannot be arrived at from the studies. To arrive at the optimum conditions for better yield, some more experiment are to be carried out in combination of MC and SET on various sizes of cashew nut.

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