Journal of the Saudi Society of Agricultural Sciences (2014) 13, 29–34

King Saud University

Journal of the Saudi Society of Agricultural Sciences

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FULL LENGTH ARTICLE

Pre-shelling parameters and conditions that influence the whole kernel out-turn of steam-boiled cashew nuts

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Received 7 August 2012; accepted 25 December 2012
Available online 3 January 2013

KEYWORDS
Whole kernel out-turn;
Steam exposure time;
Cashew nuts;
Moisture content;
Nut sizes

Abstract This work investigates the effect of moisture content (MC), nut size distribution and steam exposure time (SET) on the whole kernel out turn (WKO) of cashew nuts during shelling using a 3 x 5 x 4 factorial experiment. Three nut sizes: small (18–22 mm), medium (23–25 mm) and large (26–35 mm); five levels of MC: 8.34%, 11.80%, 12.57%, 15.40%, 16.84% (wet basis) and four levels of steam exposure time (SET): 28, 30, 32, and 34 min were considered. Nuts were conditioned with warm water to the desired moisture content of 8.34%,11.80%, 12.57%, 15.40% and 16.84% (wb); and steam-boiled at 700 kPa for 28, 30,32, and 34 min. The pre-treated nuts were shelled using a hand-operated cashew nuts shelling machine. The results showed that the single effect of MC, steam exposure time (SET) or nut size distribution is not enough for estimating WKO; it is rather by an interaction of these parameters. The optimum WKO of steam-boiled nuts was 91.74%, 90.94% and 87.98% for large, medium and small sized nuts at MC*SET combination of 8.34%*30 min, 11.80%*32 min and 8.34%*30 min, respectively. Pre-treatment of cashew nuts by steam boiling was found to improve whole kernel out-turn of the cashew nut. Whole kernel out-turn decreased as MC increased, thereby limiting the need for moisture adjustment when nuts are to be processed by steam boiling.

1. Introduction

Cashew nut is one of the prized edible nuts in the world; others include almond, pistachio, peanut, hazelnut, and walnut. It refers to the ash-green or greyish-brown kidney-shaped seed at the base of cashew apple which weighs between 4–6 g and measures about $24 \times 22 \times 17$ mm in length × width × thickness (Agnoloni and Giuliani, 1977; Oloso and Clarke, 1993; Balasubramanian, 2001 and Ogunsina and Bamgboye, 2007). Fig. 1 shows the internal structure of a cashew nut featuring the kernel, the testa and the shell. The kernel is the edible portion which is widely eaten as a snack-food for accompanying drinks at cocktails or an ingredient for confectioneries and bakery products. 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,

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Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

1658-077X
http://dx.doi.org/10.1016/j.jssas.2012.12.005

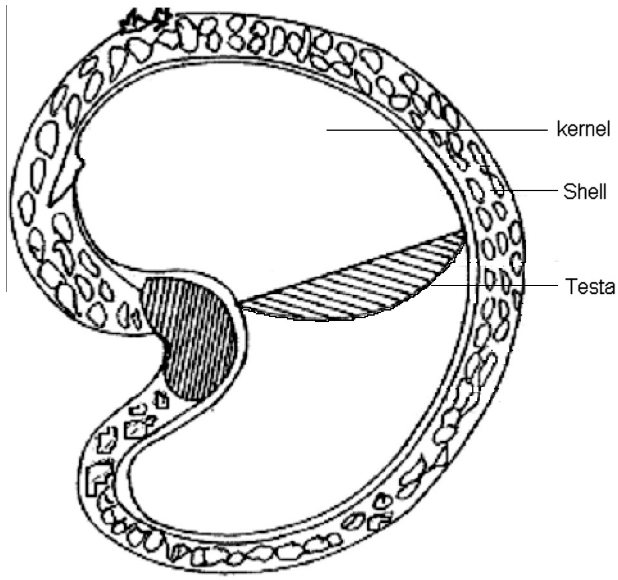

Figure 1 Schematic drawing of a longitudinally sectioned cashew nut.

which limits the internal cavity. Cashew kernel is reported to be rich in fat (46%), protein (21.2%) and carbohydrates (22.3%); providing 596 kCal of energy per 100 g of intake. In addition, it contains substantial amounts of essential amino acids, vitamins and minerals which are seldom found in daily diets (The Wealth of India, 1985). The high-oleic-acid in cashew kernel oil, apart from making it an excellent frying oil, makes it useful as fruit polish, vegetable-based lubricant, feedstock for the oleo-chemical industry or in food systems wherein high oxidative stability is prime (Holland et al., 1991; Davis, 1999 and Janick and Paull, 2008). The tannin content of the seed coat (testa) is a useful resource in the leather manufacturing industry (Andrighetti et al., 1994). Resin extracts from cashew nut shell liquid is a valuable material for manufacturing acid-resistant paints, inks, varnishes, insecticides, fungicides, lacquers for decorating vases and friction powder for automobile brake linings and clutch discs (Laurens et al., 1997; Panda and Panda, 1991 and Echendu et al., 1995). The conversion of processed cashew nut shells into alternative fuels by pyrolysis has also been reported (Ogunsina et al., 2009). Cashew nut may therefore be considered to be a crop of high economic value.

Commercial trade in cashew nuts began in the early 1920s when India pioneered its processing and marketing as an industry. Today, cashew nut production and processing is a major source of foreign revenue in India, Vietnam, Brazil, Mozambique, Tanzania and other countries along the sea coast wherein cashew tree has found favourable conditions for growth (Agnoloni and Giuliani, 1977; Andrighetti et al., 1994). Nigeria ranks among the world's top producers of cashew nuts with about 660,000 tonnes in 2009 (FAOSTAT, 2009).

The processing of most edible nuts often requires conditioning or subjecting them to one form of thermal treatment or the other to make their shell brittle and amenable to cracking (Kahyaoglu and Kaya, 2006; Shakerardekani et al., 2011). For cashew nuts, thermal treatment involves roasting the nuts in air or in oil during which the caustic liquid in the mesocarp of the shell gets burnt or dislodged. Afterwards, the nuts are tumbled in wood ash or sawdust to absorb residual liquid film on the shell, cooled and cracked having turned brittle (Andrighetti et al., 1994; Azam-Ali and Judge, 2001). However, the products of the reaction that occurs between sugars and amino acids during roasting of edible nuts lead to certain desirable sensory attributes such as flavour, colour and taste (Nikzadeh and Sedaghat, 2008) which limit industrial application of cashew nuts. Roasted cashew nuts therefore yield kernels of low export value but it is usually preferred by local consumers. In addition, cashew nut roasting, though requires minimum investment, generates thick acrid fume that pollutes and makes the environment very uncomfortable (ITDG, 2001, 2005; Azam-Ali and Judge, 2001). With the growth of the cashew nut industry and several applications of cashew kernels in food systems, export quality demands that processed nuts should be whole and white or ivory in colour to attract premium price and this is rarely achievable by roasting. An alternative thermal treatment which overcomes these limitations involves steam-boiling (Fig. 2) the dried nuts at about 100 psi for about 25–30 min and cooling it naturally for 12–24 h (Balasubramanian, 2006). This preserves the white or ivory colour and improves whole kernel out turn (WKO); hence a preferred method in industrial processing of cashew nuts for export.

Several attempts to mechanize cashew nut shelling have recorded little success, low whole kernel out turn being a major problem for the industry. Processing procedures had hitherto been based on the experience of processors rather than scientific understanding of the process (Kahyaoglu, 2008). Researchers in the past found that the behaviour of nuts during processing largely depends on processing parameters such as moisture content, size distribution and the method of thermal treatment among others (Araújo and Ferraz, 2006; Balasubramanian, 2001; Jain and Kumar, 1997; Oloso and Clarke, 1993). Such previous works on walnuts, macadamia, pistachios, hazelnuts, almonds and cashew nuts focused on the effect of thermal treatment on the chemical properties, col-

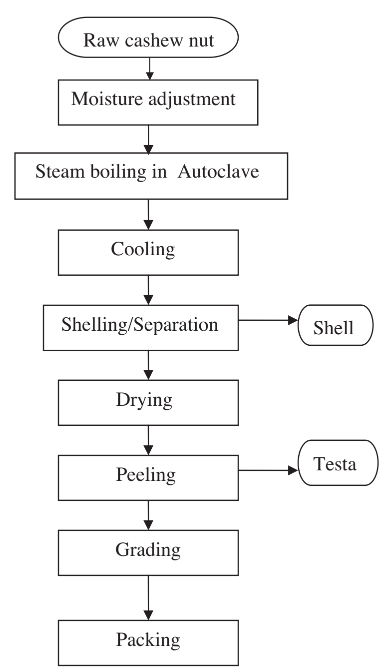

Figure 2 Cashew nut processing by steam boiling method.