Industrial Crops and Products 69 (2015) 378–384

Contents lists available at ScienceDirect

Industrial Crops and Products

journal homepage: www.elsevier.com/locate/indcrop

Dehulling of coriander fruit before oil extraction

Roque L. Evangelista[a,*], Milagros P. Hojilla-Evangelista[b], Steven C. Cermak[a], Terry A. Isbell[a]

[a] Bio-Oils Research Unit, U.S. Department of Agriculture, Agricultural Research Service, National Center for Agricultural Utilization Research,[1] 1815 N. University Street, Peoria, IL 61604, USA

[b] Plant Polymer Research Unit, U.S. Department of Agriculture, Agricultural Research Service, National Center for Agricultural Utilization Research,[1] 1815 N. University Street, Peoria, IL 61604, USA

ARTICLE INFO

Article history:
Received 29 September 2014
Received in revised form 20 February 2015
Accepted 23 February 2015
Available online 9 March 2015

Keywords:
Coriander
Dehulling
Coriander oil
Oil extraction

ABSTRACT

Coriander (*Coriandrum sativum* L.) is a summer annual traditionally grown for use as fresh green herb, spice or for its essential oil. The essential oil is obtained by steam distillation of crushed fruit and the residue is utilized as feed or processed further to recover the triglyceride. The triglyceride is obtained from the whole fruit by mechanical pressing or by solvent extraction. The coriander fruit has low density due to the void space between the mericarps and the high proportion of hulls in the fruit's weight. Dehulling oilseeds before oil extraction is commonly employed whenever it is practical to do so, but this technique has not been applied to coriander seeds. This study evaluated the feasibility of dehulling coriander fruits as part of the seed preparation before oil extraction and developed a simple process of dehulling coriander. Coriander fruit with 17.6% oil and 10% moisture was dehulled by first splitting the fruit using an impact huller or a roller mill. Seeds still encased in the split hulls were loosened further using the impact huller. The hulls were removed by screening, aspirating, or using a gravity separator. Dehulled seed with purity >95% was attainable. Dehulling the coriander fruit reduced the weight by 50% and reduced the volume by 60%. Dehulling coriander also doubled the oil content, increased the crude protein by 70%, reduced the crude fiber by 28%, and reduced other carbohydrates by 65%. The coriander fruit and dehulled seeds with purity up to 95% were amenable to screw pressing. Prepressing and solvent extraction would be more appropriate for pure dehulled seeds due to their high oil content. Dehulled seeds must be oil extracted right away to minimize the increase in free fatty acid.

Published by Elsevier B.V.

1. Introduction

Coriander (*Coriandrum sativum* L.) is an annual herb crop traditionally grown for use as a fresh green herb (cilantro) or as a spice. It is, however, mainly cultivated for its fruit which is widely used as a seasoning. Coriander is grown in most agricultural areas except in the tropics and polar regions. The major producers are Russia, Ukraine, Hungary, Poland, Canada, India, Pakistan, Turkey, Guatemala, Mexico, and Argentina (Diederichsen, 1996; Lopez et al., 2008). The fruit contains 0.3–1.2% essential oil, of which 60–70% is linalool, the compound that gives the pleasant characteristic odor. The essential oil is widely used as flavoring in a variety of food products. The fruit also contain 19–21% fatty oil (triglyceride), which has a dark brownish green color. Petroselinic acid (C18:1 $\Delta 6$) is the main fatty acid (up to 80%) in the fatty oil (Kleiman and Spencer, 1982). Coriander oil is of interest because of its potential application in oleochemistry (Placek, 1963). Petroselinic acid, an isomer of oleic acid, opens up another approach to the manufacture of medium chain fatty acids (MCFAs), since it can be split into lauric (C12:0) and adipic (C6) acids by oxidative cleavage. Lauric acid is utilized as a raw material for softeners, emulsifiers, detergents, and soaps (Reiter et al., 1998). Adipic acid is used for the manufacture of a wide range of polymers, including high grade engineering plastics. Methyl esters of coriander fatty oil have excellent fuel properties as a result of its unique fatty acid composition. The methyl esters exhibited higher oxidative stability, superior low temperature properties, and lower iodine value than soybean oil methyl esters (Moser and Vaughn, 2010).

The coriander fruit is globular or ovate and made up of two mericarps. Each mericarp contains one seed. The coriander fruit has

* Corresponding author. Tel.: +1 309 681 6312; fax: +1 309 681 6524.
E-mail address: Roque.Evangelista@ars.usda.gov (R.L. Evangelista).

[1] Disclaimer: Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture. USDA is an equal opportunity provider and employer.

http://dx.doi.org/10.1016/j.indcrop.2015.02.057
0926-6690/Published by Elsevier B.V.

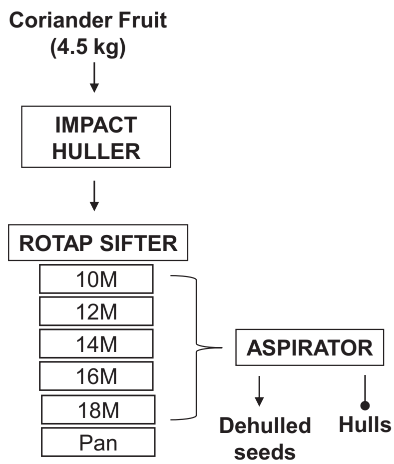

Fig. 1. Scheme for laboratory-scale (4.5 kg) dehulling of coriander fruit.

low density due to the void space between the mericarps and the high proportion of hulls in the fruit's weight. Dehulling oilseeds are employed whenever it is practical to do so. Seed dehulling is usually performed before oil extraction to reduce the amount of material to be processed, thus increasing the throughput of the downstream processing equipment. The hulls absorb a considerable amount of oil, thus reducing oil yield. Dehulling also reduces maintenance costs associated with the wear of the lining bars and shaft of the screw press. Furthermore, dehulling increases the protein content of the meal and reduces the wax that gets extracted with the oil (Buhr, 1990; Williams and Hron, 1996; Liu et al., 1996; Carelli et al., 2002).

Dehulling typically consists of two operations. The first step is to crack the hull using bar hullers, impact hullers, disk hullers, cracking rolls, and hammer mills. Next, the hulls are separated from the kernels (often called meats) by sieving, aspiration, gravity table, or other techniques (Galloway, 1976; Lusas, 1983). Impact-type dehuller has been used for sunflower seeds (Subramanian et al., 1990; Gupta and Das, 1999). Roller and impact mills were utilized in dehulling crambe (Reuber et al., 2001), while a bar huller was employed for delinted cottonseeds (Ridlehuber, 1977). Other oilseeds require some pretreatment before dehulling. For soybeans, the moisture is first adjusted to 10% and the tempered beans are cracked using a roller mill (Fetzer, 1983). For canola seeds, exposure to saturated steam and then drying loosens the hulls, which then facilitates dehulling using an abrasive dehuller (Thakor et al., 1995). Published reports on extraction of fatty oil from coriander used whole coriander fruit (Illes et al., 2000; Mhendi et al., 2011; Sriti et al., 2011; Sriti et al., 2012). No study on dehulling of coriander has been reported in literature. In this work, we investigated the feasibility of dehulling coriander fruit and developed a simple process that could be used as part of the preparation of coriander seeds for oil extraction.

2. Materials and methods

2.1. Materials

The coriander was supplied by Weinlaeder Seed Co. (Drayton, ND, USA). The coriander fruits were sized using a 10-mesh mill-grade screen to remove the smaller fruit. The screened fruits were stored in covered 0.8 m^3 polyethylene bins at ambient conditions.

2.2. Coriander fruit dehulling

The huller used in this study was a Forsberg Impact Huller Model 15-D (Forsbergs Inc., Thief River Falls, MN, USA). Details of this huller were reported previously (Evangelista, 2007). The feed control was set to dispense 2 kg of coriander fruit per minute into the hulling chamber. For laboratory-scale dehulling (Fig. 1), whole coriander (4.5 kg) was passed twice through the impact huller running at 1130 rpm. Another batch was dehulled with the impact huller operating at 1700 rpm. The milled coriander was then screened using a Ro-Tap sieve shaker (Model RX 29, W.S. Tyler, Mentor, OH, USA) and standard testing sieves (Table 1). The free hulls from fractions larger than 18-mesh were separated by using a Bates laboratory aspirator (H.T. McGill, Houston, TX, USA). Each fraction was weighed, and the moisture and oil contents were determined.

Table 1
Screen opening of the U.S. standard sieves and mill-grade screens used in sizing the milled coriander.

Screener	U.S. standard sieve no.	Mill-grade mesh No.	Opening (mm)
Ro-tap	10	–	2.00
	12	–	1.70
	14	–	1.40
	16	–	1.16
	18	–	1.00
Rotex	–	10	2.03
	–	18	1.03

The dehulling was scaled-up to 45.4 kg and processed as illustrated in Fig. 2. After the first pass through the impact huller, the dehulled seeds were screened using a two-deck Rotex Model 12 A screener (Rotex Inc. Cincinnati, OH, USA) fitted with a 10-mesh (10 M) and an 18-mesh (18 M) mill-grade screen (Table 1). The fraction from the top of the 10 M screen (+10 M) was passed through the impact mill a second time to loosen the seeds that were still encased in the hull and then screened again. The weights of the fractions were obtained and the moisture and oil contents were determined.

A roller mill (Miag Vario Roller Mill Model C, Braunschweig, Germany) was also employed in place of the impact huller in the

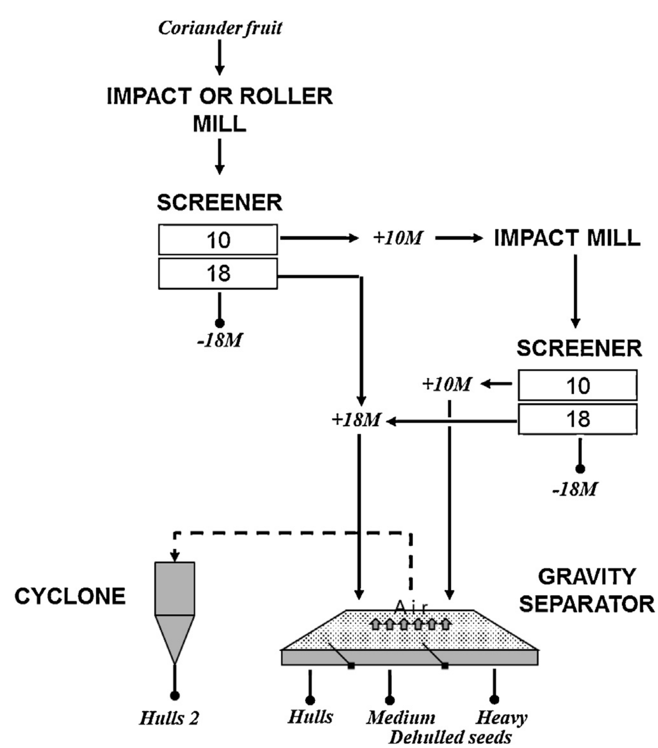

Fig. 2. Scheme for dehulling 45.4 kg of coriander fruit.