Available online at www.sciencedirect.com

SCIENCE DIRECT®

Innovative Food Science and Emerging Technologies 6 (2005) 143–153

Innovative Food Science & Emerging Technologies

www.elsevier.com/locate/ifset

An innovative process for the production of spices through immediate thermal treatment of the plant material

Ute Schweiggert, Klaus Mix, Andreas Schieber*, Reinhold Carle

Hohenheim University, Institute of Food Technology, Section Plant Foodstuff Technology, August-von-Hartmann-Strasse 3, D-70599 Stuttgart, Germany

Received 2 August 2004; accepted 22 November 2004

Abstract

An innovative process for the production of spices was developed on pilot-plant scale. Immediately after harvest, fresh chili and green pepper (fruits), ginger (rhizomes), and coriander (whole plant) were blanched and subjected to coarse and fine grinding prior to lyophilization. Alternatively, thermal treatment was applied after processing the fresh plant material into a paste. Microbiological assays revealed low counts of aerobic germs, aerobic spore forming bacteria, *Escherichia coli*, coliforms, *Staphylococcus aureus*, *Bacillus cereus*, yeasts and moulds, and sulfite reducing clostridia. *Salmonella* as well as aflatoxins were not detected in any of the products. Because the spice powders obtained were generally characterized by improved color, in contrast to conventional spice processing, early inactivation of endogenous enzymes may have prevented degradation of plant pigments and browning.

Keywords: Spices; Green pepper; Chili; Ginger; Coriander; Color; Volatile oils; Pungency; Microbial load

Industrial relevance: Spices are common sources for microbial contaminations with special concern in minimally processed products. Sterilization of spices has been shown to adversely affect product quality criteria and ionizing or UV radiation have been met with consumer resistance. Pasteurization/sterilization or blanching as thermal processes effective in reducing microbial loads and inactivating enzymes. However, loss of volatiles could not be prevented in the process presented and needs to be tackled prior to industrial scale use.

1. Introduction

Antiquity spices and herbs not only have been used for seasoning since, but also for cosmetical and medical purposes. Spice products are usually prepared by drying of the raw material as a whole or in coarsely cut form. The plant material is commonly spread on the ground and sun-dried, whereas artificial drying and the use of solar-dryers is scarce. Finally, the dried product is ground; however, care must be taken to minimize the loss of volatile compounds.

Most spices are produced in tropical and subtropical regions. The hot and humid climate, the simple, unpretentious production conditions, extended drying times, and often inadequate instructions of the farmers may cause considerable hygienic and quality problems (Gerhard, 1990). As a consequence, high microbial loads (up to 10^8 cfu/g) may be found in spices, as shown for black pepper and paprika (Baxter & Holzapfel, 1982; McKnee, 1995). Bacterial contamination poses a tremendous risk, especially when spices are added to food without subsequent preservation, since microbial counts may dramatically increase until consumption. Furthermore, spore forming bacteria may cause spoilage of canned foods and processed meat products. Although yeasts and moulds have generally been found in smaller numbers, *Aspergillus* species may create serious problems in chili and paprika, as well as in ginger, coriander, and pepper because of their aflatoxin producing potential (Flannigan & Hui, 1976; Garrido, Jodral, & Pozo, 1992). Since thermal preservation is impossible, inhibition of microbial growth in the raw material by drying is the most efficient way to reduce microbiological and aflatoxin contamination.

* Corresponding author. Tel.: +49 711 459 3125; fax: +49 711 459 4110.

E-mail address: Schieber@uni-hohenheim.de (A. Schieber).

1466-8564/$ - see front matter © 2004 Elsevier Ltd. All rights reserved.
doi:10.1016/j.ifset.2004.11.006

During conventional spice production the slow decrease of water activity enhances browning and chlorophyll degradation. Furthermore, deteriorating enzymes (e.g. lipoxygenase, peroxidase, and polyphenoloxidase) may also regain their activity, especially during storage of spices under humid conditions and after rehydration of dry foods. Since endogenous as well as microbial enzymes may adversely affect color, texture, taste, and aroma of spices and foods, their immediate inactivation is also a prerequisite for high quality spices.

Therefore, the objective of the present study was to develop an alternative process for the production of spices and herbs with low contamination rates and of high quality with respect to color and volatile compounds. In contrast to conventional spice production, inactivation of enzymes and microorganisms should be achieved. Due to their economic importance, chili pods and green pepper (fruits), ginger (rhizomes), and coriander (whole plants) were exemplarily chosen.

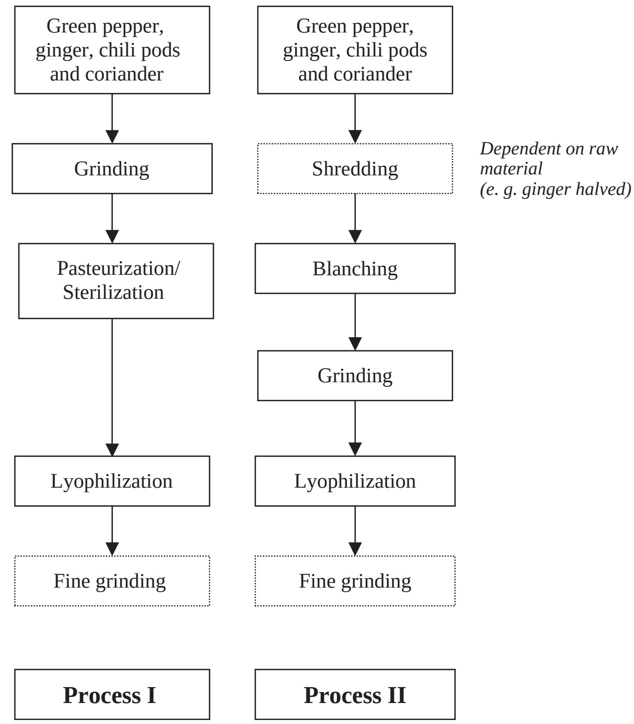

Fig. 1. Scheme of the new process for the production of spices (steps in dotted lines are optional).

2. Materials and methods

2.1. Plant material

Green pepper and fresh ginger rhizomes were obtained from organic production in Thailand, where sulfite has not been used. Chilis were purchased from a local market. Coriander was cultivated at the Hohenheim University Experimental Station for Horticulture, and immediately processed after harvest in July (during blossoming) and August (green mature seeds).

2.2. Processes for producing spice powders

2.2.1. Green pepper (*Piper nigrum* L.)

3 kg of panicles were heated in a boiler at 90 °C for 10 min or at 100 °C for 5 and 10 min using water and steam, respectively. After blanching and subsequent cooling in ice-water for 1 min the fruits were picked. Alternatively, 200 g of panicles were filled in cans containing 800 mL of water. The cans were autoclaved at 110 °C for 1 and 5 min, respectively, and at 120 °C for 1 min in a rotary retort (Rotopilot 5, Stock, Neumünster, Germany) at 0.7 bar. The blanched as well as autoclaved berries were minced to a pasty mash in a corundum mill (type MK 95, Fryma, Rheinfelden, Germany) with a gap of 0.4 mm. Due to frictional forces the temperature of all spice pastes increased up to 60 °C. Finally, the paste was lyophilized (Fig. 1, Process II). Lyophilization of all spices was achieved by freezing the paste at −30 °C at 100 mbar for 1.5 h. Pressure was then reduced to 45 mbar in 1 min. Within 8.5 h the temperature was linearly increased to 20 °C and kept constant for 2 h. Subsequently, the temperature was further increased to 35 °C and the pressure was decreased to 35 mbar in 5 h. The temperature was kept constant for 55 h, whereas the pressure was linearly decreased to 15 mbar. Total run time was 70 h. Finally, the dried product was milled to a fine powder using a S1/2 ball mill (Retsch, Haan, Germany).

2.2.2. Ginger (*Zingiber officinale* L.)

3 kg of fresh, unpeeled rhizomes were minced in a cutter (type K20, Seydelmann, Aalen, Germany) for 1.5 min and then ground in a corundum mill with a gap of 0.4 mm. The ginger paste was heated in a hermetically sealed 3 L pilot-plant scale reaction vessel (type EL 3, ESCO-Labor AG, Riehen, Switzerland) at 80 °C for 10 min, at 90 °C for 5 and 10 min, and at 100 °C for 1 and 10 min (Fig. 1, Process I), respectively. Alternatively, thermal treatment was performed before grinding (Fig. 1, Process II). The washed rhizomes were cut into halves and blanched at 100 °C for 10 min in water and steam, respectively. After heating, the plant material was ground and the ginger mash was lyophilized as described above and powdered using the ball mill.

2.2.3. Chili (*Capsicum annuum* L.)

2.5 kg of fresh red chili pods were coarsely ground in a cutter for 1.5 min, prior to comminution in a corundum mill with a gap of 1 mm. The chili paste was heated in the reaction vessel at 80 °C for 10 min, at 90 °C for 5 and 10 min, and at 100 °C for 5 min, respectively (Fig. 1, Process I). Alternatively, the chilies were blanched before grinding (Fig. 1, Process II). The washed pods were blanched at 80 °C for 10 min, at 90 °C for 5 and 10 min, and at 100 °C for 5