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Review

Chamomile harvesters: A review

Hanna Brabandt, Detlef Ehlert*

Leibniz-Institute for Agricultural Engineering Potsdam-Bornim e.V., Max-Eyth-Allee 100, 14469 Potsdam, Germany

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ABSTRACT

The large-scale production of chamomile (*Matricaria recutita* L.) in developed countries can be realized only by the mechanization of the harvest process. Based on literature sources and patent databases, the current status of picking principles was analyzed and systematized in this study. Taking into account the practical use of chamomile harvesting principles, it can be concluded that linearly moved picking combs with additional stalk cutting, rotating picking combs with central and outside discharge of flowers, and rotating pin drums are used most widely.

Taking into account the flower quality and picking efficiency, rotating picking drums with comb sections achieve the best results. The most important reason for quality losses was the load on the flowers due to wiper blades for reducing the stem length. The limitation of the picking efficiency was caused mostly by the defined maximum drum rotation speed to ensure the discharge of picked flowers from the combs. The maximum drum rotation speed was a result of the ratio of gravity and centrifugal forces on flower heads for a given drum diameter.

For improving chamomile harvesters, the authors preferred an increase of the ground speed instead of a higher working width to achieve a higher productivity. However, due to the increased ground speed, the rotation speed of the picking drum has to be increased simultaneously to reduce the feeding depth for single comb strokes. To develop a new chamomile harvester for commercial use, further scientific investigations are necessary to perfect the picking principle in detail and incorporate solutions for the conveying, storage and discharge of flowers.

Contents

1. Introduction

Chamomile (*Matricaria recutita* L.) is important among existing medicinal plants and is cultivated throughout the world to obtain the essential oil from the flower heads. It is produced mainly in Argentina, Egypt, France, Germany, Hungary, and the former Yugoslavia (Nidagundi and Hegde, 2006). Worldwide, approximately 20,000 ha of chamomile flowers are grown (Ehlert et al., 2011).

For example, in Germany, chamomile is cultivated on about 1000 ha (Anonymous, 2006a,b). The harvesting process of flower heads is an important factor for successful drug production. It determines the amount and the quality of the product harvested (Zimmer and Müller, 2004). For the use of chamomile as a medicinal plant, the raw material has to fulfill high demands concerning quality parameters. In particular, stem rests remaining on the flower heads have to be as short as possible. Other constituents, such as leafs or soil rests, should be avoided. These recorded requirements are mainly achieved by manual crop picking. However, only low picking amounts of about 3–5 kg h^{-1} can be obtained (Ebert, 1982; Plescher, 1997; Zimmer and Müller, 2004; Franke and Schilcher, 2005). Franke and Schilcher (2005) specified an annual yield up to 800 kg of dry drug ha^{-1} under German conditions. Thus, a labor time requirement of 160–267 h ha^{-1} can be calculated. Therefore, this practice is still applied only in low-wage countries, e.g., in Egypt or in small cultivation areas.

* Corresponding author.
E-mail address: dehlert@atb-potsdam.de (D. Ehlert).

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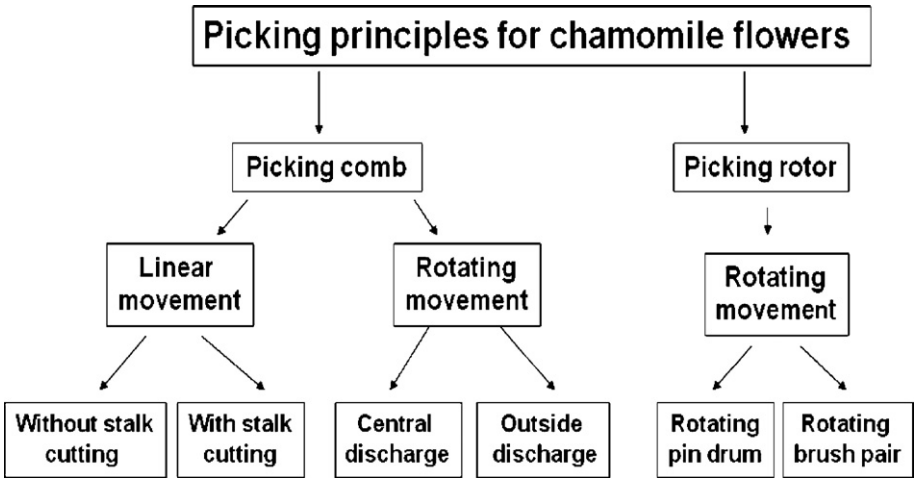

Fig. 1. Diagram for the demonstration of picking principles.

A slight enhancement can be achieved with a picking comb (Müller, 2003).

Nevertheless, large-scale production can be realized only by a mechanization of the harvesting. Hence, today, different chamomile producing countries, e.g., Argentina, Slovakia, Serbia, Italy and Germany, use mechanized harvesting techniques based on different picking principles. The constructions vary between tractor-mounted machines and self-propelled harvesters. There exist only rare publications about technical investigations and improvements (Müller, 2003). The development of these machines mainly took place in the 1970s and 1980s. To improve chamomile harvesting, the most recent developments occurred in Serbia in the 1990s (Martinov et al., 1992; Pajic et al., 2007a) and nowadays in Italy. Others have not been established in praxis (Mohr and Hecht, 1996; Vangeyte et al., 2008) or were accomplished by the growers themselves without any documentation.

In Germany, for example, the domestic production of medicinal plants increased during the past few years due to a higher interest in phytopharmaceuticals, better quality and quality controls of regional products (Bomme, 1998). However, in 2004, the national cultivation area covered only 15% of German demand for chamomile flowers because the central- and southern-European countries (e.g., Poland and Bulgaria) offered flowers for lower prices (Anonymous, 2006b).

To increase the competitiveness of the medicinal and aromatic crop market in general and to intensify production, new solutions for harvesting techniques are absolutely inevitable.

Considering the general state of the art, it should be possible to fulfill the increasing requirements of competitive chamomile production. Therefore, the revival of research and technical innovation is necessary, focusing on increasingly powerful harvest techniques with simultaneous consideration of quality parameters.

2. Objectives

For the development of improved chamomile harvesters, the first step and the main objective of this paper is the analysis of the current status of chamomile harvesting techniques based on used working principles. The second objective is to discuss the weaknesses of the existing solutions and outline principles for more efficient and profitable chamomile harvesters. This should be performed based on experience with existing techniques and by taking into account the progress in other technology fields like manufacturing, sensors and other machine development outside of drug harvesting.

3. Analysis of picking principles

The picking principle is crucial for the productivity and flower head quality of chamomile. Therefore, the following survey is focused on picking principles. For analyzing the current status of chamomile harvesters, two basic principles can be distinguished, a “picking comb” and a “picking rotor” (Fig. 1). Picking combs are moved linearly or rotated. Linearly moved picking combs can be designed without and with additional cutting of stalks. Rotating picking combs are characterized by central and outside discharge of the flower heads. Picking rotors are known in the form of pin drums and brush pairs (Fig. 1).

Linearly moved picking combs without stalk cutting are mainly hand-held devices and manually pushed picking carts. Hand-held devices such as picking combs or shovels achieve picking amounts of about 10–15 kg fresh flowers per hour (Zimmer and Müller, 2004). Such techniques require a labor time of about 25–30 working days ha^{-1} with a manually pushed picking cart, which can also be drawn by horses or tractors (Franke and Schilcher, 2007).

Linearly moved picking combs with additional stalk cutting (Fig. 2) was a principle described in a German patent specification (Anonymous, 1975a). To reduce the remaining stalk length, a circulating chain drive attached to shearing bars is proposed. Similar principles were used in Argentina and Italy in different constructions for practical use. The Argentinean type uses a fixed comb section to tear the flower heads by movement in the driving direc-

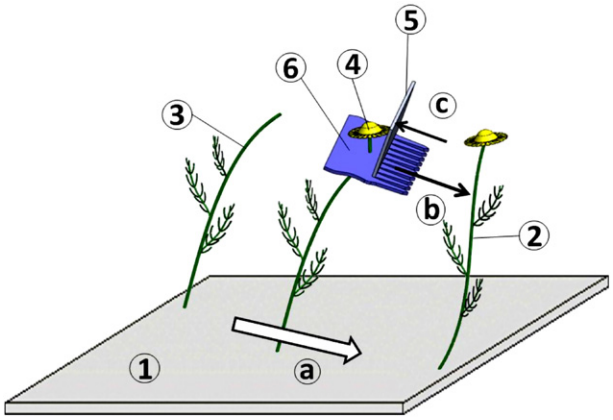

Fig. 2. Linearly moved picking comb with additional stalk cutting. 1, ground; 2, unharvested plant; 3, harvested plant; 4, cut flower head; 5, wiper blade; 6, comb; a, driving direction; b, comb moving direction; c, movement of stalk wiper blade.