Werner B. Herppich, Bernd Herold, Oliver Schlüter and Martin Geyer, Potsdam

Effects of Product Physiology on the Cutting Quality of Small Radishes

The market for ready-to-eat fresh salads is growing rapidly worldwide. To prepare these products, cutting and peeling is always necessary. Low processing quality increases the risk of spoilage and reduces shelf-life. Optimizing processing methods can restrict losses. Furthermore, physiological properties of the produce affect the cutting quality considerably. Optimized preconditioning could reduce produce losses, too. In this investigation the interactive effects of temperature, water status, and texture on small radish tubers (Raphanus sativus L.) is examined more closely.

Cutting and/or peeling of fresh produces which are essential steps during processing of ready-to-eat fresh salads inevitably damage cells and tissue structures. It is unavoidable that during these processes cell sap and enzymes are released, the natural protection against phytopathogenic microorganisms is reduced and the contact area for decay reactions is largely increased. Finally, this all results in an undesirable reduction of shelf-life. However, it has been shown that the application of produce specific optimized peeling methods [1] or cutting tools [2] partially reduce processing impacts. Especially the configuration and condition of the cutting edge, as well as cutting velocity and tool movement largely affect cutting quality [3].

On the other hand, cutting quality is also influenced by the initial status of the produce itself, its tissue structure, texture and water status. This fact is, however, very often underestimated. Beside these produce related effects processing temperature also influences tissue firmness [4]. As a result brushing, cracking and breaking susceptibility of fresh fruits and vegetables increases with decreasing temperature and increasing water status. This might imply that low temperatures and a high water status generally reduce tissue strength and, hence, facilitate a gentle cutting process. The higher the force required for cutting the product, the higher is the respective degree of damage [5].

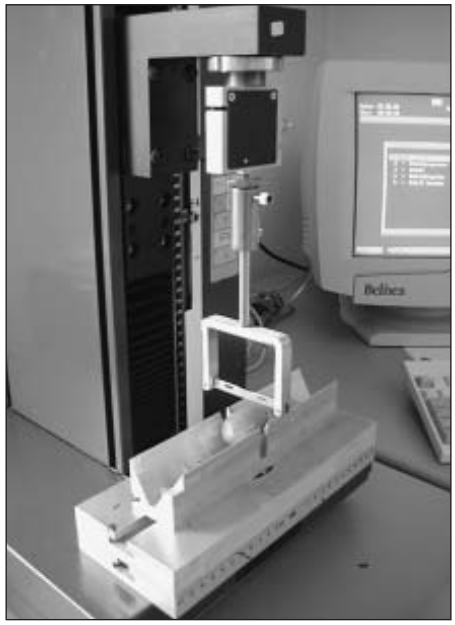

Fig. 1: For cutting, a microtome blade (Feather S35, 0.26 mm thickness), adapted to the universal testing machine (Zwicki 1120, Zwick GmbH & Co. KG, Germany) was used.

On the other hand, tissue strength is dynamically influenced by the developmental stage of the produce and its respective physiological activity [6].

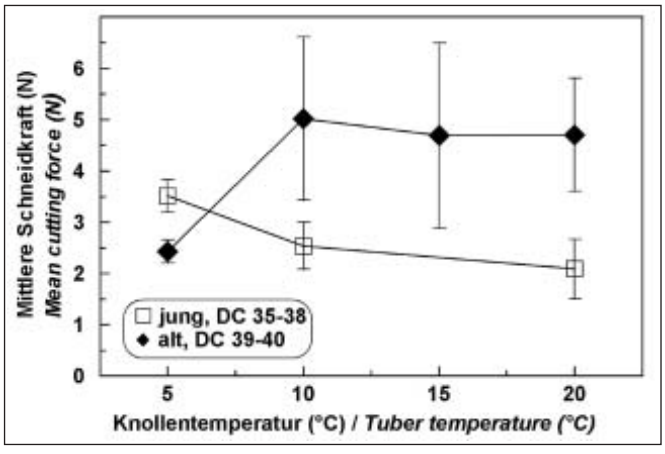

Fig. 2: Effects of temperature on the mean cutting force during cutting of young and old small radish tubers

Dr. Werner B. Herppich, Dr. Bernd Herold, Dr. Oliver Schlüter und Dr. Martin Geyer sind Mitarbeiter der Abteilung Technik im Gartenbau (Leitung: Dr. Martin Geyer) am Leibniz-Instituts für Agrartechnik Potsdam-Bornim e.V., Max Eyth-Allee 100, 14469 Potsdam; e-mail: *wherppich@atb-potsdam.de*

Keywords

Ready-to-use fresh-salad, cutting quality, produce physiology

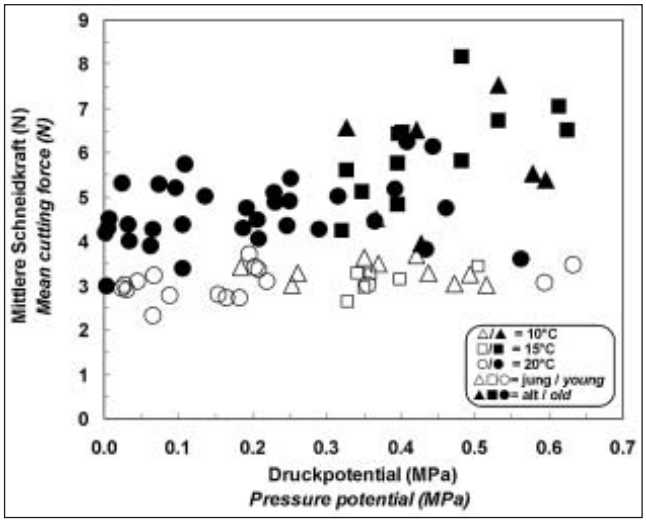

Fig. 3: Effects of pressure potential on the mean cutting force of young and old radish tubers, obtained at 10, 15 and 20°C

processed freshly harvested, because the mean cutting force and damage sensitivity are closely related. Furthermore, lower processing temperatures seem to be better suited for a gentle cutting in tuber of this developmental stage. On the other hand, temperature only marginally affects cutting quality in young radishes.

Material and methods

In this study fresh small red radishes of various ages (20 to 50 d after germination) were used. Plants were grown in a climate chamber under practically relevant conditions. Water potential of radish tubers was determined with a pressure bomb. Tissue strength, defined as the mean force necessary to radially cut the entire tuber (*Fig. 1*), was measured with microtome blade (Feather S35, 0.26 mm maximum thickness) adapted to an universal testing machine (Zwicki 1120, Zwick GmbH & Co. KG, Ulm). From the cut tuber tissue osmotic potential, pressure potential and water content were obtained.

Effects of temperature, pressure potential and age of tubers

Temperature affects cutting strength in freshly harvested radish tubers (*Fig. 2*). However, this temperature effect is non uniform, if tubers of different age are compared. In very young, just reaching the saleable seize, tissue strength is relatively high at very low processing temperature (5 °C). In contrast, in older tubers, at the end of sale ability, strength is high and nearly constant in the temperature range of 10 to 20 °C and declines at 5 °C. Stored for various time radish tubers develop a great variation in mean tissue pressure potential, i.e. the hydrostatic tissue pressure or turgor. In these tubers a clear cut relationship between cutting strength and the mechanical water status component occurs only in older tubers (*Fig. 3*). This effect is also valid in young radishes but is only weakly expressed. One reason for these diverse results obviously originates from the fact that tissue strength generally increases with the development of tubers (*Fig. 4*).

For the annual radishes the rapid growing tuber acts as intermediate storage for water and nutrients that should guarantee the sprouting of the inflorescences. Consequently these tubers have a very simple form and structure mainly consisting of large thin walled parenchyma cells. In the further course of tuber differentiation, towards the end of the vegetative growth phase, the chemical and physical properties of cell walls are reinforced [6]. As a result the stage of development strongly affects the complex interactions between water relations, temperature and cutting strength.

Conclusion

Cutting strength of radish tubers only weakly correlates with water status in general and pressure potential in particular. In young tubers the effect of turgor on cutting quality seems to be negligible, in contrast to old tubers. On the other hand, the turgor is a good indicator of the degree of freshness of the produce. Hence, older tubers should not be

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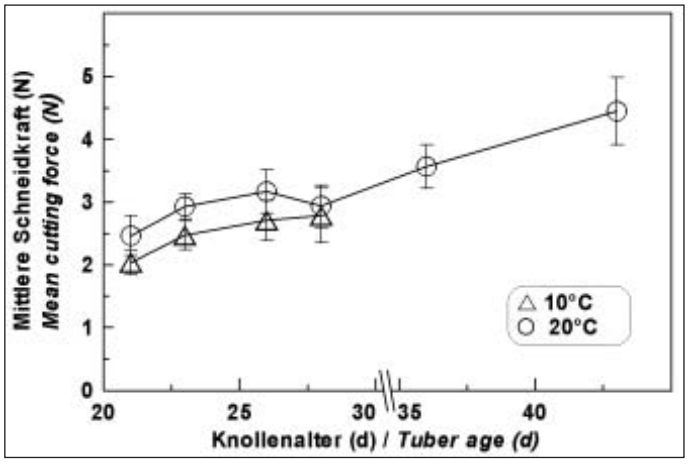

Fig. 4: Effects of differentiation on the mean cutting force as obtained at radish tuber temperatures of 10 and 20°C