8. Summary:

The objective of the work is the determination of the influence of modern and classic processing techniques on the antioxidant constituents in apple and berry juices by stepwise control during the production process of the fruit juices. Those antioxidant constituents in fruit juices are mainly represented by a group of compounds called polyphenols, which meant to have many positive effect on human health. Further determinations are performed about the influence of the variety, the ripeness and juice storage on the antioxidative capacity of the fruit juices. The most important antioxidative compounds in apple and berry juices are the polyphenols and in some berry juices L-ascorbic acid especially in blackcurrant. Apple and blackcurrant juice were chosen because of their great differences in amount and spectra of polyphenols, the amount of L-ascorbic acid and the production process. Stepwise control in the production of elderberry, blackberry, gooseberry and sour cherry juice are also carried out. The changes in antioxidative capacity and the contents of antioxidative compounds are also determined during fruit wine production and the ripening of strawberry.

The antioxidative capacity was performed by the $ABTS^{+\cdot}$-radicalcation-assay which was modified to meet the present demands. Methodological sources of error could be detected and were eliminated. The used principle of measurement for evaluating the antioxidative capacity is fast and effective.

A new method for the analysis of polyphenols by HPLC was developed using a fluorinated RP-phase and Diode-Array-Detection (DAD) and Electrochemical-Detection (ECD). A good separation of the single polyphenols, simultaneous analysis of colourless polyphenols and anthocyanins and a sensitive and informative detection using two detection systems were achieved.

Three anthocyanins from blackcurrant juice and two polyphenols from apple juice, all commercially not available, could be isolated.

Due to their high polyphenol contents, most berry juices are generally a better source of antioxidants in human nutrition than apple juice, which contains lower amounts of polyphenols. The variety has the greatest influence on the antioxidative capacity of apple and blackcurrant juice. The amounts of antioxidative components differ widely in different apple as well as blackcurrant varieties. Choosing a polyphenol-rich variety appeared to be the basis for a high antioxidative capacity in the juice.

The influence of mash treatment, mash extraction, apple polyphenol oxidase, industrial extraction system, separation, thermal treatment, storage, fining with gelatine, ultrafiltration with following stabilisation by PVPP or adsorber resin and laccase/O_2 treatment followed by ultrafiltration on apple juice during processing were studied and discussed. The extraction of the mash transfers only 32% of the potential antioxidative capacity and 43% of the polyphenols into the juice and could be considered as the processing step causing the greatest loss during juice production. Mash treatment, e.g. a hold for one hour or heating to 60°C, improves the yield of antioxidants after extraction. Different extraction systems such as horizontal press and decanter yield the same antioxidative capacity but different amounts of individual polyphenols, even though the total polyphenols (measured by the Folin-Ciocalteu method) are similar. Oxidation processes during production and separation decrease the antioxidative capacity and the polyphenols of freshly pressed apple juice 20 to 40%, which could be inhibited by heating of the freshly pressed juice to 55°C. All modern processing techniques for the production of a clear juice using ultrafiltration strongly reduce antioxidative capacity as well as the polyphenols (40 – 75%), while fining with gelatine is more gentle (25 – 40% decrease). Therefore, fining with gelatine is the favoured method for apple juice clarification. Generally, under the here applied criteria cloudy apple juice could considered to be superior to its clear counterpart.

The influence of mash extraction, separation, thermal treatment, fining with gelatine, treatment with PVPP and bentonite and concentration process on blackcurrant juice during processing were studied and discussed. Decrease of antioxidative capacity and polyphenols during blackcurrant juice processing (extraction, separation, pasteurisation) is 10 to 15%, which is reasonably lower than observed decrease in apple juice processing. Mash heating and depectinisation is recommended due to a better extraction of polyphenols from the mash

(59% antioxidative capacity, 64% polyphenols) and inhibition of polyphenoloxidase activity via temperature induced protein denaturation. Thermal treatment during the concentration process hardly reduces the antioxidative capacity and total polyphenols (Folin-Ciocalteu) but causes a massive decrease in the amounts of individual polyphenols, especially the anthocyanins. Therefore, the concentration process could not be recommended when refering to recent data on the bioavailability of anthocyanins.
Elderberry, blackberry and sour cherry show comparable stability during processing (decrease < 20%). As the generally recommended method for the clarification of berry juices occurs the fining with gelatine.
The higher amounts of antioxidants and a lower activity of polyphenol oxidases are most likely responsible for the difference in stability during processing of high coloured berry juice and apple juice. Storage of clear juices, apple and elderberry juice, reduces the total polphenols as well as the indiviual polyphenols while the antioxidative capacity remains constant. Formation of new antioxidative compounds, polymeric phenols, maillard product etc., during storage is suggested as a possible reason for the constant antioxidative capacity.
Fermentation during fruit wine processing hardly effects the antioxidative capacity while the amounts of individual polyphenols are drastically reduced. Taking this observation into account condensation and polymerisation products formed during fermentation should posses a similar antioxidative capacity as their basic molecules.
Based on the results, clear recommendations for fruit juice production can be confirmed in order to achieve the highest possible antioxidative capacity and an optimised amount of polyphenols:

1. The choice of polyphenol-rich fruits is the basis for high antioxidative capacity in the juice.

2. Heating of mash or freshly pressed juice to inactivate polyphenol oxidases.

3. A minimisation of processing steps during fruit juice production to avoid unnecessary reductionsof antioxidative capacity and polyphenols.

4. Fast and effective processing lines to avoid unnecessary hold time.

5. Avoiding all processing steps and juice treatments causing a high reduction of antioxidative capacity and individual polyphenols.

The possibility of the development of an antioxidant-rich beverage based on various berry juices could be demonstrated.
Polyphenols as fruit juice ingredients were considered from a new point of view and their changes during fruit juice processing were newly valued.
The results represent a useful tool for the fruit juice industry to evaluate fruit juice processing with the focus on antioxidative capacity and individual polyphenols and provide information for the development of new products with a high antioxidative capacity.