7 Fruits and Vegetables of Moderate Climate

Lars P. Christensen, Merete Edelenbos, Stine Kreutzmann
Department of Food Science,
Danish Institute of Agricultural Sciences,
Research Centre Aarslev,
Kirstinebjergvej 10, 5792 Aarslev, Denmark

7.1 Introduction

The flavour of fruits and vegetables is determined by taste and odour-active compounds. Taste is perceived on the tongue and odour in the olfactory system. The olfactory system is extremely sensitive; it can detect odours in amounts of parts per trillion, whereas receptors on the tongue can detect flavour compounds in amounts of parts per hundred. Sugars, acids, salts and compounds that contribute to bitterness, e.g. isocoumarins and polyacetylenes in carrots and related vegetables \([1, 2]\) and sesquiterpene lactones in chicory and lettuce \([3, 4]\), and to astringency such as phenolic acids, flavonoids, alkaloids, tannins \([5, 6]\), are important for the taste of fruits and vegetables. The perception of sweetness, which is mainly due to fructose, glucose and sucrose, is one of the most important flavours of fruit and vegetables. Sweetness may be modified by sourness or acid levels from, e.g., citric, malic, oxalic and tartaric acids and odour-active compounds. The contribution of odour-active compounds to the flavours of fresh and processed fruits and vegetables has gained increasing attention because these compounds are important for the characteristic flavours of fruits and vegetables. The present chapter contains information on odour-active volatiles of fruits and vegetables of moderate climate.

Many factors affect the volatile composition of fruit and vegetables, e.g. genetics, maturity, growing conditions and postharvest handling. Furthermore, preparation of the fruits and vegetables for consumption and the method for isolation of volatile compounds may change the volatile profile and key aroma compounds compared to non-processed fruits and vegetables.

The most difficult problem in flavour research is to interpret the results of the volatile analysis, which gives information on the identity and the quantity of the volatile compounds collected from a given product. Many volatile compounds are not flavour-active, i.e. they cannot be detected in the olfactory system, while others may even in trace amounts have significant effects on flavour owing to their low odour-threshold values that is defined as the minimum concentration needed to produce an olfactory response. Consequently, the most abundant volatiles are not necessarily the most important contributors to flavour. Much
attention has been given to identify the odour-active or character-impact com-
pounds in fruits and vegetables by various techniques based on gas chromatog-
raphy–olfactometry (GC-O). In the classic GC-O procedure, the effluent of the
GC column is split, with one portion of the eluted volatiles flowing to the instru-
ment detector and the rest to a sniff port where the odour-active compounds
are identified and described [7]. In recent years, the GC-O technique has been
combined with methods that determine the intensity of the odour-active com-
pounds by dilution techniques and determination of odour-detection thresh-
old values [7–11] as in CharmAnalysis and aromatic extract dilution analysis
(AEDA). More recently, the Osme method, which determines the quality, in-
tensity and duration of odour-active compounds, was introduced. Although all
these techniques ignore synergism and antagonism between compounds, they
seem to be the best methods to identify odour-active compounds in fruits and
vegetables at present. The information on key odour compounds given in this
chapter was mainly obtained by the use of these techniques.

7.2
Formation of Flavours in Fruits and Vegetables

A large number of volatile compounds are formed in fruits and vegetables dur-
ing maturation and preparation such as cutting, chewing and mild heat treat-
ment. The typical flavour of most fruits is not present during early fruit growth
and development but develops after a ripening process. During this period, me-
tabolism changes to catabolism and volatile compounds are formed from major
plant constituents through various biochemical pathways [12, 13]. Many cli-
macteric fruits, e.g. apples, pears, peaches, nectarines, apricots and plums, have
a green note when unripe [14]. This note disappears during ripening and the
characteristic aroma for the intact fruit becomes prominent [14, 15]. However,
this profile may change again during preparation. In stone fruits, for example,
glycoside-bound monoterpenic alcohols and lactones are released upon macera-
tion [16, 17].

The release of volatile compounds owing to cutting, chewing and mild heat
treatment is an uncontrolled effect, where enzymes are mixed with primary and
secondary metabolites that are separated in the intact tissue. Cooking for a long
time or at high temperature can result in the formation of a whole new group
of volatile flavour compounds that are usually a result of the breakdown of car-
bohydrates, proteins, lipids and carotenoids. Volatile compounds produced by
severe cooking may completely overshadow key flavour compounds of fruits
and vegetables, but they are not included in this chapter.

Volatile compounds formed by anabolic or catabolic pathways include fatty
acid derivatives, terpenes and phenolics. In contrast, volatile compounds formed
during tissue damage are typically formed through enzymatic degradation and/
or autoxidation reactions of primary and/or secondary metabolites and includes
lipids, amino acids, glucosinolates, terpenoids and phenolics.