

Dietary Fibre Content of Thirteen Apple Cultivars

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(Received 8 March 1996; revised version received 14 October 1996; accepted 16 April 1997)

Abstract: Fibre composition of the following 13 apple cultivars was studied: 'Cortland', 'Empire', 'Fuji', 'Golden Delicious', 'Gala', 'Granny Smith', 'Jonagold', 'Mutsu', 'McIntosh', 'Delicious', 'Rome', 'Stayman' and 'York'. Fruit samples from each of these cultivars were analysed for non-starch cell wall materials (NSCWM) and non-starch polysaccharides (NSP). NSCWM was further fractionated into soluble and insoluble fibre fractions. Both NSCWM and NSP content were found to be significantly influenced by cultivar. NSCWM content ranged from 19.1 g kg⁻¹ apple flesh in 'Fuji' to 36.2 g kg⁻¹ in 'York'. Mean (\pm SD) NSCWM content of all the cultivars was 23.1 \pm 4.5 g kg⁻¹. NSP content of apple flesh ranged from 13.8 g kg⁻¹ in 'McIntosh' to 28.7 g kg⁻¹ in 'York' with the overall mean for all cultivars being 17.9 \pm 4.2 g kg⁻¹. Relative amount of monosaccharides found in the hydrolysates of apple fibre also varied among cultivars. The greatest difference was observed in galactose content.

J Sci Food Agric 75, 333-340 (1997)

No. of Figures: 0. No. of Tables: 5. No. of References: 14

Key words: *Malus domestica*, apple, dietary fibre, firmness, soluble fibre, insoluble fibre

INTRODUCTION

Dietary fibre is the sum of lignin and polysaccharides not hydrolysed by the endogenous secretions of the human digestive tract (Trowell 1976). Fibre is believed to help in the prevention of certain diseases and health problems such as diabetes (Anderson and Bryant 1986), diverticular diseases (Painter and Burkitt 1971) and obesity (Anderson and Bryant 1986). Increased understanding of the role of dietary fibre in human health and nutrition has prompted nutritionists all over the world to emphasise the importance of dietary fibre in the human diet. However, foods with different fibre composition function differently in the human body. For any dietary recommendation of dietary fibre to be truly effective, it is important not only to know the fibre

content but also the fibre composition of food materials and how various factors affect fibre content and composition.

Apples (*Malus domestica*) are an important source of dietary fibre. Detailed fibre composition of apple has been reported (Theander and Aman 1979; Ross *et al* 1985; Marlett 1992). These studies involved only one (Theander and Aman 1979) or two (Ross *et al* 1985; Marlett 1992) apple cultivars. However, Gormley (1981) reported significant differences in dietary fibre content of 'Golden Delicious', 'Red Jonathan' and 'Cox's Orange Pippin' apples. Wiley and Thompson (1960) analysed 'Stayman', 'Golden Delicious', 'York Imperial', 'Rome Beauty', 'Jonathan' and 'North West Greening' apples and reported significant cultivar effects on pectin content. Cellulose content has also been reported to differ significantly among apple cultivars (Kertesz *et al* 1959). An effective database on apple fibre content and

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composition should be based on values from a number of apple cultivars because of genetic differences among cultivars. No such extensive database currently exists. The objective of the current research was to describe the fibre content and composition of 13 apple cultivars.

EXPERIMENTAL

Materials

The following 13 cultivars were sampled: 'Delicious', 'Golden Delicious', 'Rome', 'McIntosh', 'Granny Smith', 'Stayman', 'York', 'Fuji', 'Jonagold', 'Cortland', 'Empire', 'Mutsu' and 'Gala'. Fruit were obtained from commercial orchards in Western North Carolina during summer of 1993. Fruit belonging to the same cultivar came from the same orchard and same year's growth. Also, since all the apples came from the same region, they may be assumed to have been grown under similar climatic and soil conditions. All the fruit were harvested at commercial market maturity. Ten apples, randomly chosen from the harvested fruit, constituted a sample for fibre analysis. Three samples of each cultivar were analysed and each sample constituted a true replicate.

Determination of firmness and soluble solid content of apples

Firmness of apples was measured using an Effegi penetrometer with an 11 mm tip mounted on a drill press. Apples were peeled and tested on two opposing sides and the values were averaged. Soluble solid content was determined by placing juice squeezed directly from the apple onto a refractometer. The firmness and soluble solid values of these apples at sampling are listed in Table 1.

Extraction of non-starch cell wall materials

Non-starch cell wall materials (NSCWM) were extracted from apple pulp according to Southgate's method (Southgate 1981). The fruit were peeled and cored, and 80 g of flesh was homogenised with 95% ethanol. The amount of ethanol added was adjusted so as to make the extraction at 85% (v/v). The mixture was heated on an electric hot plate, brought to a boil and filtered hot through a Buchner funnel using Whatman 541 filter paper. The residue was resuspended in 85% ethanol followed by heating and filtration as before. This process was repeated once and the tissue was then extracted twice in acetone in a similar way. The extracts were discarded and the residue was dried overnight in a vacuum oven at 35°C. The dried residue constituted the cell wall material (CWM) of apple flesh. The starch portion in CWM was removed through enzymatic hydrolysis. Amyloglucosidase (from *Aspergillus niger*,

TABLE 1
Firmness and soluble solid content of apples^a

Cultivar	Flesh firmness (N)	Soluble solids (g kg ⁻¹ flesh)
Cortland	54.8 ± 5.5	137 ± 7
Empire	61.5 ± 5.8	155 ± 10
Fuji	71.2 ± 5.2	165 ± 7
Gala	90.9 ± 4.6	117 ± 8
Golden Delicious	55.4 ± 5.1	148 ± 10
Granny Smith	74.6 ± 3.8	126 ± 6
Jonagold	53.8 ± 4.3	127 ± 7
McIntosh	54.6 ± 6.2	117 ± 8
Mutsu	70.3 ± 4.7	120 ± 10
Delicious	76.0 ± 4.8	91 ± 5
Rome	83.9 ± 5.3	121 ± 10
Stayman	73.8 ± 7.0	118 ± 8
York	123.8 ± 6.5	141 ± 10

^a Values are mean ± SD (n = 3).

lyophilised, Boehringer Mannheim) stock solution was prepared by dissolving 100 mg amyloglucosidase (6 U mg⁻¹ lyophilisate) in 10 ml citrate solution (pH 4.6). The citrate solution consisted of 44 mg citric acid·H₂O and 85 mg trisodium citrate·2H₂O dissolved in 10 ml distilled water. To perform enzymatic hydrolysis of starch molecules in cell wall materials, approximately 300 mg of the dried CWM sample was put in a centrifuge tube with 4 ml of hot water. The tubes were placed in a boiling water bath for 10 min to gelatinise the starch in the sample. After cooling, 0.2 ml 2 M sodium acetate buffer (pH 5.0) was added to the mixture. Amyloglucosidase stock solution was diluted 1:5 (v/v) with water and 1 ml of this diluted solution along with a few drops of toluene was added to each tube. The tubes were then kept overnight in an incubator (37°C). The next morning five volumes of 95% ethanol were added to the mixture and the mixture was centrifuged. The supernatant was extracted and the extraction process was repeated using 80% ethanol. The residue was washed with acetone and dried. The dried residue represented NSCWM of apple pulp and contained non-starch polysaccharides (NSP), lignins, some proteins and minerals.

Fractionation of NSCWM into soluble and insoluble fractions

Approximately 150 mg of the dried NSCWM sample was placed in a centrifuge tube with 10 ml hot water. Tubes were placed in a boiling water bath for 20 min. After cooling, the mixture was centrifuged. The residue was resuspended in hot water and the extraction procedure was repeated. The supernatants were then combined and the residue was washed with acetone

