

Acta fytotechnica et zootechnica – Mimoriadne číslo
Nitra, Slovaca Universitas Agriculturae Nitriae, 2009, s. 286-290

VYUŽITIE JABLČNEJ VLÁKNINY V PEKÁRSTVE

USE OF APPLE FIBRE IN BAKERY PRODUCTS

Zlatica KOHAJDOVÁ, Jolana KAROVIČOVÁ, Stanislava ŠIMKOVÁ

Institute of Biotechnology and Food Science, Department of Food Technology, Bratislava, the
Slovak Republic

Abstract: Nowadays, there is a growing demand for a new generation of healthier food products which at the same time have excellent sensory qualities. Epidemiological studies pointed out that the human diet is at present deficient in fibre, which leads to numerous health complications. Supplementation has been used to enhance fibre content of food products. There are two reasons to add fibre to baked products: the increase of dietary fibre intake and the decrease of the caloric density of baked goods. Traditionally, fibre supplementation into the bakery products is focused on the use of milling by-products. There are many other sources of dietary fibre, such as fruits and vegetables. Apples (powder obtained from apple skin, apple concentrate, apple pomace) could be considered as an alternative dietary fibre source applicable into the bread and other baked goods (muffins, cookies, cakes), cereal and granola products. Further, the apple fibre is characterised with favourable functional properties and can be used for production of new type of functional bakery products.

Key words: fibre, apples, by-products, bakery products quality

Since the mid-1960s the interest in the nutritional implications of dietary fibre has continued to grow (Nawirska, Uklaňska, 2008). Dietary fibre is defined as lignin plus the polysaccharide components of plants which are indigestible by enzymes in the human gastrointestinal tract. These components are typically divided into two categories (insoluble and soluble dietary fibre). (McKee, Latner, 2000). Insoluble dietary fibre fractions (cellulose, lignin, hemicellulose) shorten the gastrointestinal transit time and thus prevent constipation; they exert an inhibiting effect on the development of many rectal cancer forms by favourably stimulating the growth of intestinal microflora and preventing that of putrefactive bacteria (Nawirska, 2005; Nawirska, Uklaňska, 2008). Whole grains are good sources of insoluble fibre (McKee, Latner, 2000). Soluble dietary fibre fractions (pectin, gum, some of the hemicelluloses) undergo bacterial fermentation in the gastrointestinal tract and influence the metabolism of carbohydrates and fats (Nawirska, 2005; Nawirska, Uklaňska, 2008). Good sources of soluble fibres include fruits, vegetables, legumes, soybeans, psyllium seeds and oat bran (McKee, Latner, 2000).

Apples are a good source of dietary fibre with a well-balanced proportion of soluble and insoluble fibre fractions (Rupasinghe, Wang, Huber et al., 2008; McKee, Latner, 2000; Gorinstein, Zachwieja, Folta et al., 2001; Figuerola, Hurtado, Estevéz et al., 2005). Apples also offer some advantages over cereal brans and legume hulls. It lacks phytic acid which renders minerals like zinc unavailable (Masoodi, Shiarma, Chuan, 2002; Larrauri, 1999). Apple fibre (AF) can be used as a dietary fibre source in certain food products (Chen, Rubenthaler, Leung et al., 1988a; McKee, Latner, 2000). Apple fibre is presented by higher content of total dietary fibre than either wheat or oat brans (Chen, Rubenthaler, Leung et al., 1988a; McKee, Latner, 2000). Dietary fibre composition of selected cereal brans and dietary fibre concentrates is presented in Table 1 (Grigelmo-Miguel, Martin-Bellosso, 1999).

Table 1 Dietary fibre composition of selected cereal brans and dietary fibre concentrates

Source	Total dietary fibre (1)	Insoluble dietary fibre (2)	Soluble dietary fibre (3)
	(g per 100 g dry matter)		
Apple (4)	60.1	46.3	13.8
Pear (5)	36.1	22	14.1
Orange (6)	37.8	24.2	13.6
Peach (7)	35.8	26.1	9.7
Artichoke (8)	58.8	44.5	14.3
Asparagus (9)	49	38.6	10.4
Wheat bran (10)	44	41.1	2.9
Oat bran (11)	23.8	20.2	3.6

Tabuľka 1 Obsah potravinovej vlákniny vo vybraných druhoch cereálnych otrúb a vlákninových koncentrátoch

(1) celková potravinová vláknina, (2) nerozpustná potravinová vláknina, (3) rozpustná potravinová vláknina, (4) jablko, (5) hruška, (6) pomaranč, (7) broskyňa, (8) artyčokky, (9) špargľa, (10) pšeničné otruby, (11) ovsené otruby

Apple fiber preparation

Apple pomace is the main by-product resulted from pressing apples for juice (Sudha, Baskaran, Leelavathi, 2007) or cider and it accounts for 25-35 % of the mass of apple (Masoodi, Shiarna, Chuan, 2002; Gullón, Falqué, Alonso et al., 2007). Dried apple pomace is considered as a potential food ingredient having a high dietary fibre content (Carson, Collins, Penfield, 1994; Sudha, Baskaran, Leelavathi, 2007).

AF concentrates can be obtained by washing, coring, chopping, and separation of juice from pomace by pressing. Apple pomace is washed twice with warm water (30 °C); then is dried at 60 °C during 30 min in an air tunnel drier and ground to a particle size of 500–600 µm (Figuerola, Hurtado, Estevéz et al., 2005). The material is washed under mild conditions to avoid or minimise losses of some soluble fibre components (such as pectins and pentosans) as well as bioactive components (such as flavonoids, polyphenols and carotenes). Washing allows reduction of free sugar and ash contents (Larrauri, 1999). Drying is the main and most expensive step in dietary fibre production. It improves the fibre shelf life without the addition of any chemical preservative and reduces both the size of package and the transport costs (McKee, Latner, 2000). Drying at temperatures below 65 °C avoids changes in the functional properties and in the content of polyphenols, tannins, anthocyanidins and proteins (Larrauri, 1999). Grinding to a relative large particle size, is done to not affect the hydration characteristics on the textures of the apple fibre concentrates (Kethireddipalli, Hung, Philips et al., 2002).

For preparation of apple skin fibre powder are apple skins immediately after peeling blanched with boiling potable water for 30 s to prevent enzymatic browning. After draining the excess water and within 3 h of blanching treatment. The apple skins are dried in clean plastic trays at 60 ± 2 °C for 48 h using a convection oven with air circulation. The dried skins are ground into a fine powder using a mill with 1 mm sieve screen (Rupasinghe, Wang, Huber et al., 2008).

The alkaline extracted AF posed possible textural problems due to the potential formation of crystalline sites (Walter, Rao, Sherman et al., 1985; McKee, Latner, 2000).

Application of apple fibre in bakery industry

Epidemiological studies have related inadequate fibre intake to a wide spectrum of diseases like atherosclerosis, diverticulosis, colonic cancer and appendicitis. Plant fibres are often added to foods

to lower incidence of these disorders and dilute calories. Because of their high consumption, baked food products are potential carriers of dietary fibre. Many fibre sources have been identified and are being used in various baked products (Masoodi, Shiarma, Chuan, 2002).

AF may have a potential use in bread baking (Chen, Rubenthaler, Leung et al. 1988a). AF increases the water absorption and loaf weight of breads, but results in lower loaf volume when compared to products made with wheat or oat brans (Chen, Rubenthaler, Leung et al., 1988a; McKee, Latner, 2000). This effect is attributed to the interaction between fibre and gluten, which led to a decrease in the gas retention capacity. Some additives, such as vital gluten or oxidising and emulsifying agents, would have to be added to counteract the unwanted effect of fibre addition on the dough handling characteristics and the bread volume reduction (Gómez, Ronda, Blanco et al., 2003). It was also found that breads with fibre have a longer lifetime. This effect is related to the well known water binding capacity of fibre that avoids water loss during storage and with the possible interaction between fibre and starch that would delay the starch retrogradation (Gómez, Ronda, Blanco et al., 2003).

In general apple pomace fibre affects the elastic properties of the wheat flour dough as well as the pasting properties (Sudha, Baskaran, Leelavathi, 2007). Chen, Rubenthaler, Schanus (1988b) and Sudha, Baskaran, Leelavathi (2007) stated that increase in apple pomace content in the flour blends from 0 % to 15 %, increased the water absorption and dough development time and decreased dough stability. It was shown that increased water absorption by fibre addition is expected due to the hydroxyl groups in the fibre structure, which allow more water interactions through hydrogen bonding (Gómez, Ronda, Blanco et al., 2003). An increasing in dough development time indicates that an increase in fibre content in the blends has slow the rate of hydration and development of gluten. Mixing tolerance values increased, which is due to dilution of gluten protein with the fibre content. This may also be due to the interaction between fibrous materials and gluten, which affects the dough mixing properties. These authors (Chen, Rubenthaler, Schanus, 1988b; Sudha, Baskaran, Leelavathi, 2007) also found that with increase in apple pomace content, the resistance to extension value increases and extensibility values decrease. This may be either due to the dilution of gluten proteins or interactions between polysaccharides and proteins from wheat flour.

Impact of apple pomace on the pasting properties was also determined. Pasting temperature, which is the first deflection of temperature in amylogram, where the curve begins to rise increased from 60 to 63 °C with increase in apple pomace content from 0 % to 15 % (Sudha, Baskaran, Leelavathi, 2007). The difference in pasting temperature may be due to the effect of varying gelation temperatures of the fibre fractions (Naruenartwongsakul, Chinnam, Bhumiratana et al., 2004; Sudha, Baskaran, Leelavathi, 2007). Peak viscosity decreased with increase in the apple pomace in the blends indicating that the swelling power, which is the ability of the starch granules to swell freely before their break down decreased. The breakdown values, which is related to the starch, increased with increase in the pomace content. The higher breakdown values at higher concentration of pomace content indicate that the fibre fraction interacted with the starch and make the swollen granules more fragile (Sudha, Baskaran, Leelavathi, 2007).

Sensory evaluation results indicates that the apple pomace muffins have good texture and flavour and are sweeter, softer and more moist than the control (bran muffins) (Wang, Thomas, 1989). Similar results were recorded for AF cookies (McKee, Latner, 2000). Also it was found that addition of apple pomace in cake making can avoid the application of other flavouring ingredients as the cakes prepared with apple pomace had pleasant fruity flavour (Sudha, Baskaran, Leelavathi, 2007).

Conclusion

Dietary fibre is a common and important ingredient of a new generation of healthy food products demanded more each day by customers. Dietary fibre increases the nutritional value of bakery products but usually at the same time alters rheological properties of dough and, finally, the quality

and sensorial properties of products (Gómez, Ronda, Blanco et al., 2003). Apples can be used as a good source dietary fiber (McKee, Latner, 2000). The main sources of AF are apple pomace (Carson, Collins, Penfield, 1994; Sudha, Baskaran, Leelavathi, 2007) and apple skins (Rupasinghe, Wang, Huber et al., 2008). AF is successfully added into bread (Masoodi, Shiarma, Chauhan et al., 2002) and other bakery products such as muffins, cookies and cakes (Wang, Thomas, 1989; McKee, Latner, 2000; Sudha, Baskaran, Leelavathi, 2007).

Súhrn: V súčasnej dobe narastá dopyt po novej generácii zdravších potravinových produktoch, ktoré sa zároveň vyznačujú vynikajúcimi sensorickými vlastnosťami. Epidemiologické štúdie poukázali na nedostatočný príjem vlákniny v ľudskej výžive, čo vedie k rôznym zdravotným ťažkostiam. Pridávanie vlákniny do potravín môže napomôcť k zvýšeniu jej obsahu v potravinárskych výrobkoch. Existujú dve príčiny pridávanie vlákniny do pekárskeho výrobku: zvýšenie príjmu vlákniny a zníženie kalorickej hodnoty výrobkov. Vedľajšie produkty získané v priebehu mlynského spracovania obilnín sú považované za hlavné zdroje vlákniny pridávané do pekárskeho výrobku. Existujú však aj iné zdroje vlákniny ako napr. ovocie a zelenina. Jablká (prášok získaný z jablkovej šupky, jablkový koncentrát, jablková drvina) môžu byť považované za alternatívny zdroj potravinovej vlákniny aplikovateľný do pekárskeho výrobku ako sú chlieb, ostatný pekársky tovar (muffiny, keksy, koláče) a cereálne obilninové produkty. Jablková vláknina sa ďalej vyznačuje priaznivými funkčnými vlastnosťami a preto sa môže použiť pri výrobe nových typov funkčných pekárskeho výrobku.

Kľúčové slová: vláknina, jablká, vedľajšie produkty, pekárske výrobky

This paper was resolved within the research projects: VEGA (Grant No. 1/0570/08), AV (Grant No. 4/0013/07) and APVV (Grant No. 031006).

References

- CARSON, K. J. - COLLINS, J. L. - PENFIELD, M. P. 1994. Unrefined, dried apple pomace as a potential food ingredient. In: *Journal of Food Science*, vol. 59, p. 1213–1215.
- FIGUEROLA, F. – HURTADO, M. L. - ESTÉVEZ, A. M. et al. 2005. Fibre concentrates from apple pomace and citrus peel as potential fibre sources for food enrichment. In: *Food Chemistry*, vol. 91, p. 395-401.
- GOMEZ M. - RONDA, F. - BLANCO, C. A. et al. 2003. Effect of dietary fibre on dough rheology and bread quality. In: *European Food Research and Technology*, 2003, vol. 216, p. 51-56.
- GORINSTEIN, S. – ZACHWIEJA, Z. – FOLTA, M. et al. 2001. Comparative content of dietary fibre, total phenolics, and minerals in persimmons and apples. In: *Journal of Agricultural and Food Chemistry*, vol. 49, p. 952–957.
- GRIGELMO-MIGUEL, N. - MARTIN – BELLOSSO, O. 1999. Comparison of dietary fibre from by-products of processing fruits and greens and from cereals. In: *Lebensmittel-Wissenschaft und-Technologie*, vol. 32, p. 503-508.
- GULLÓN, B. – FALQUÉ, E. – ALONSO, J. L. et al. 2007. Evaluation of apple pomace as a raw material for alternative applications in food industries. In: *Food Technology and Biotechnology*, vol. 45, p. 426-433.
- CHEN, H. – RUBENTHALER, G. L. – LEUNG, H. K. et al. 1988a. Chemical, physical and baking properties of apple fibre compared with wheat and oat bran. In: *Cereal Chemistry*, vol. 65, p. 244–247.
- CHEN, H. – RUBENTHALER, G. L. – SCHANUS, E. G. 1988b. Effect of apple fibre and cellulose on the physical properties of wheat flour. In: *Journal of Food Science*, vol. 53, p. 304–305.

- KETHIREDDIPALLI, P. – HUNG, Y. C. – PHILIPS, R. O. et al. 2002. Valuating the role of cell material and soluble protein in the functionality of cowpea (*Vigna unguiculata*) pastes. In: *Journal of Food Science*, vol. 67, p. 53–59.
- LARRAURI, J. A. 1999. New approaches in the preparation of high dietary fibre powders from fruits by-products. In: *Trends in Food Science and Technology*, vol. 10, p. 3–8.
- MASOODI, F. A. - SHIARMA, B. - CHAUHAN, G. S. 2002. Use of apple pomace as a source of dietary fibre in cakes. In: *Plant Foods for human Nutrition*. vol. 57, p. 1211-128.
- McKEE, L. H. - LATNER, T. A. 2000. Underutilised sources of dietary fibre: A review. In: *Plant Foods for Human Nutrition*. Vol. 55, p. 285-304.
- NARUENARTWONGSAKUL, S. – CHINNAM, M. S. – BHUMIRATANA, S. et al. 2004. Pasting characteristics of wheat flour-based batters containing cellulose ethers. In: *Lebensmittel-Wissenschaft und-Technologie*, vol. 37, p. 489–495.
- NAWIRSKA, A. - UKLAŃSKA, C. 2008. Waste products from fruit and vegetable processing as potential sources for food enrichment in dietary fibre. In: *Acta Scientiarum Polonorum - Technologia Alimentaria*, vol. 7, p. 35-42.
- NAWIRSKA, A. - KWAŚNIEWSKA, M. 2005. Dietary fibre fractions from fruit and vegetable processing waste, In: *Food Chemistry*, vol. 91, p. 221-225.
- RUPASINGHE, H. P. – WANG, L. – HUBER, G. M. et al. 2008. Effect of baking on dietary fibre and phenolics of muffins incorporated with apple skin powder. In: *Food Chemistry*, vol. 107, p. 1217-1224.
- SUDHA, M. L. - BASKARAN, V. - LEELAVATHI, K. 2007. Apple pomace as a source of dietary fibre and polyphenols and its effect on the rheological characteristics and cake making. In: *Food Chemistry*, vol. 104, p. 686-692.
- WALTER, R. H. – RAO, M. A. – SHERMAN, R. M. et al. 1985. Edible fibres from apple pomace. In: *Journal of Food Science*, vol. 50, p. 747–749.
- WANG, H. J. – THOMAS, R.L. 1989. Direct use of apple pomace in bakery products. In: *Journal of Food Science*, vol. 54, p. 618–620.

Contact address: Ing. Zlatica Kohajdová, PhD., Institute of Biotechnology and Food Industry, Department of Food Technology, Radlinského 9, 812 37 Bratislava, Slovak republic, e-mail: zlatica.kohajdova@stuba.sk