HIGH CONTENT OF SOLUBLE DIETARY FIBER IN PASTA PRODUCTS. CONSIDERATION, TECHNOLOGICAL ASPECTS AND IMPROVEMENT OF THE FINAL PRODUCT

G. Mohan, A. Voitovici, M. Grigorescu, A. Mirea, A.Culetu
S.C. MP Baneasa S.A., 52-54 Nicolae G. Caramfil Street, 1st district, Bucharest

Abstract

The new pasta product obtained from whole wheat flour, fibruline instant (1,9%) and swelite (1,9%) is a high dietary fiber source, present an increased content of soluble fiber and has a better water binding capacity. The rheological characteristics and the technological properties of the product are improved compared with the martor sample and sample with inuline.
Keywords: *dietary fiber, chicory inulin, pea fiber, whole wheat flour*

Introduction

Dietary fiber is a general term for plant polysaccharides and lignin that are not broken down by the digestive enzymes of human beings. Dietary fiber is found in plant cell walls, gums and algal polysaccharides. Division of fibers by their solubility in water is the most common method of classification, and is convenient because many of the physiological properties of fiber seem to be based on this physical property. As a rule, water-soluble fibers (inulin, pectin, gums, β glucans) form viscous solutions and are used in the food industry as emulsifiers, food thickeners, and gelling agents. In the body, soluble fibers are associated with lipid and carbohydrate metabolism. This type of fiber binds also the cholesterol to remove it from the body.

Insoluble dietary fibers, such as cellulose, hemicellulose, lignin, resistant starch, speeds up the passage of food in intestines and removes waste products including carcinogens.

Burkitt (1975) was the first to report the physiological importance of dietary fiber consumption. Based on epidemiological studies, he showed associations between low-fiber diets and chronic disorders such as constipation, colon cancer, diabetes and cardiovascular disease. Since the 1970s research has been carried out that, for the most part, confirms the role of dietary fiber in disease prevention. Prevention of cancer is also considered

a health benefit of high-fiber diets. Epidemiological studies indicate that dietary fiber, and in particular a diet rich in cereals and vegetables, helps to prevent colon cancer.

The positive effect of dietetic fiber, due to their multiple functions (such as hypoglycemic, hipocolesterolic, the prevention of heart disease, the reducing of intestinal cancer incidence) and the important action of the fructans (inulin and olygosaccharides) of being non-digestible in the colon were the two reasons which inspired us to improve our existing special pasta products.

In this study we used: whole wheat flour; chicory inulin – a soluble dietary fiber extracted from chicory roots using a natural process; pea cell wall fiber – also a natural food ingredient obtained from the cell walls of yellow peas.

Whole wheat flour (type 1750) has the complete wheat kernel including endosperm, bran and germ. The bran and the germ are rich in fiber, vitamins (B group, E), minerals (magnesium, zinc, iron, potassium, phosphorus and calcium), antioxidants, carotenoids and flavones.

Chicory inulin is a soluble dietary fiber extracted from chicory roots using a natural process.

Belonging to the fructan group, inuline is a non-digestible olygosaccharide, built up of fructose units with β 2-1 bonds mostly ending by a glucose unit.

Inulin from chicory is a natural soluble dietary fiber. Some characteristics of the inulin: promotes digestive comfort being a prebiotic and bifidus promoter; enhances calcium absorption; is a low calorie ingredient (1-1,3 Kcal/g).

Pea fiber is a natural food ingredient, a highly valuable vegetable fiber source with clean label benefit: GMO and gluten free.

Experimental

Whole wheat flour was obtained in Baneasa mill that use a Buhler technology.

Fibruline Instant and Swelite are premium products manufactured by Cosucra Group Warcoing Belgium and we used them as source of inuline, respectively pea fiber.

The characteristics of Fibruline Instant composition based on DM from the technical sheet of the producer are: total carbohydrate (min 99,8%),

inulin (min 90%), free fructose, glucose and saccharose (max 10%), ash (max 0,2%).

And for Swelite the composition based on DM is: total carbohydrate (93 +/-3 %), total dietary fibers (48 +/- 3%), starch (min 36%), proteins (N x 6,25; max 7%), ash (max 2%) and fat (max 0,5%).

In our experiments we used three samples: no.1: Whole wheat flour, no.2: Whole wheat flour + 3,8% fibruline instant and no.3: Whole wheat flour + 1,9% fibruline instant + 1,9% swelite.

The rheological parameters of the samples were obtained using the Alveograph Chopin and Brabender farinograph – which gives us the image of the modifications for the parameters involved in the technological processability of the dough.

The manufacturing process of the pasta was achieved in the pasta side Baneasa.

Results and Discussion

At the beginning we analyzed the raw material; and the physical characteristics of whole wheat flour are: gluten content (19,2%) and water content (14,8%).

The rheological parameters issued from the alveogram: resistance (175 mm H_2O), extensibility (17 mm), energy (143 $Jx10^{-4}$), P/L ratio (10,59). Then, we have analyzed the influence of ingredients on the physical chemical characteristics (table 1) and rheological aspects of the flour (table 2). The shape of the curves obtained with the farinograph is presented in figure 1.

Table 1: The Influence of the Ingredients on Physical Chemical Characteristics.

Sample	Water content (%)	Ash content (%)	Protein Content (%)	Gluten content (%)	Falling number (sec)
No. 1	14,8	1,64	12,57	19,2	306
No. 2	13,8	1,58	12,2	18,4	294
No. 3	13,8	1,59	12,35	18,4	302

We can observe that from this point of view the changes are not so important; besides a slight decrease of the protein content, it is also noticed a decrease of the gluten content, which is expected, due to the different behavior of the proteins.

Table 2: The Influence of the Ingredients on Rheological Aspects

Sample	Water absorption capacity CH (%)	Development time D (min)	Stability S (min)	Dough softening I (UF)	Elasticity E (UF)	Strength
No.1	64,4	6,5	12,4	50	50	67
No.2	66,5	8,5	19,3	20	60	80
No.3	68	10	21	10	60	82

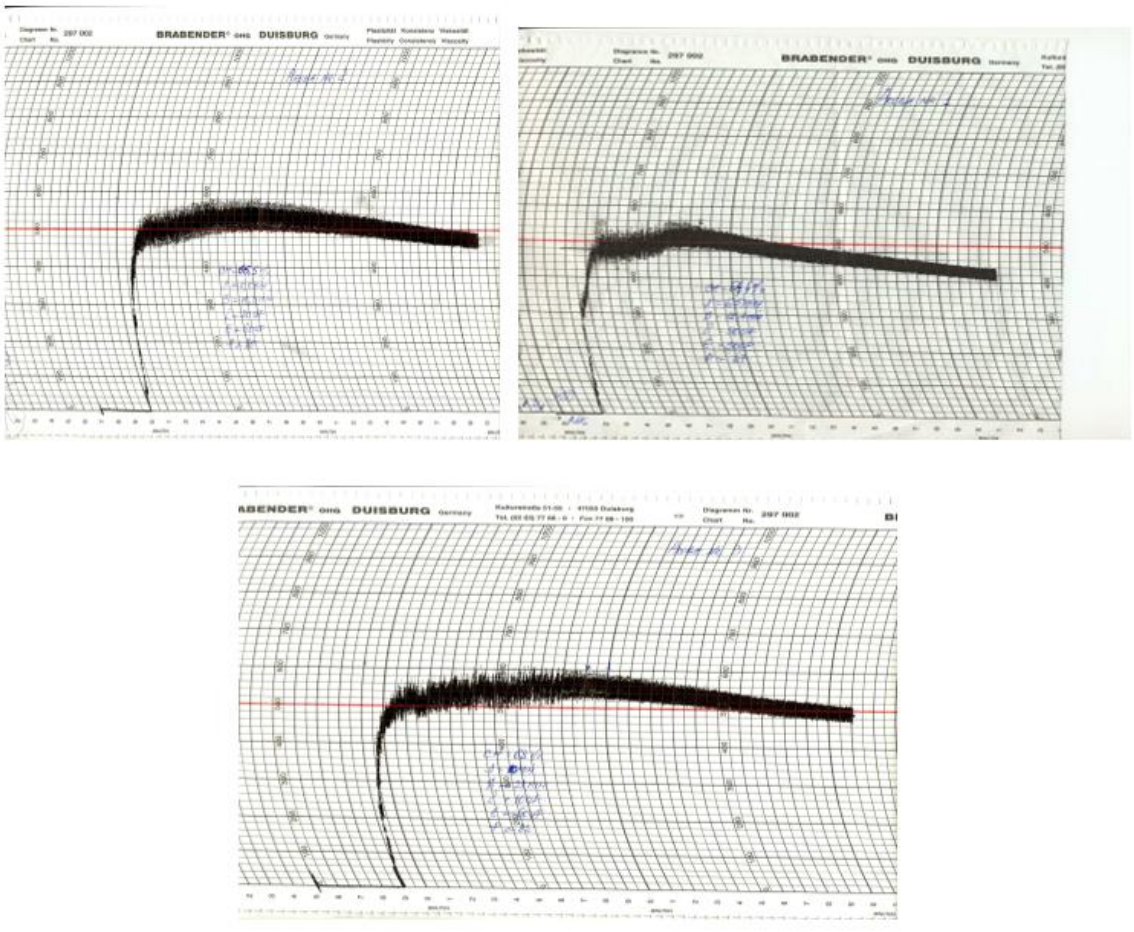

Fig. 1: The farinograms of the three samples

From the point of view of rheological aspects we can assert:

– the water absorption capacity is improved by adding chicory inulin and pea fiber,

– the development time is longer with about 31% for no.2 flour compares with flour no.1, and with about 54% for no.3 compares with flour no.1,

– the stability time is better registered; from whole grain flour to inulin enriched flour it is noticed an increasing with about 55%; this trend is

continuously also from the second to the third flour, but in a smaller percentage (13%),
– the global score – strength – of the flour is also improved, with about 19% from flour no. 1 to flour no. 2 and with about 2,5% from flour no.2 to flour no.3,
– the dough softening values are decreasing because of higher stability.

The technological process is a "friendly" one in principal for two reasons: the mixing and kneading operations take place in special conditions, under vacuum, in order to avoid the oxygen contact and to maintain unaltered the main properties of the raw material, and the second one, the drying process is a classical one, which means low temperatures for the different phases of drying and also long dry time. In figure 2 is presented the diagram of the technological process for manufacturing the pasta products.

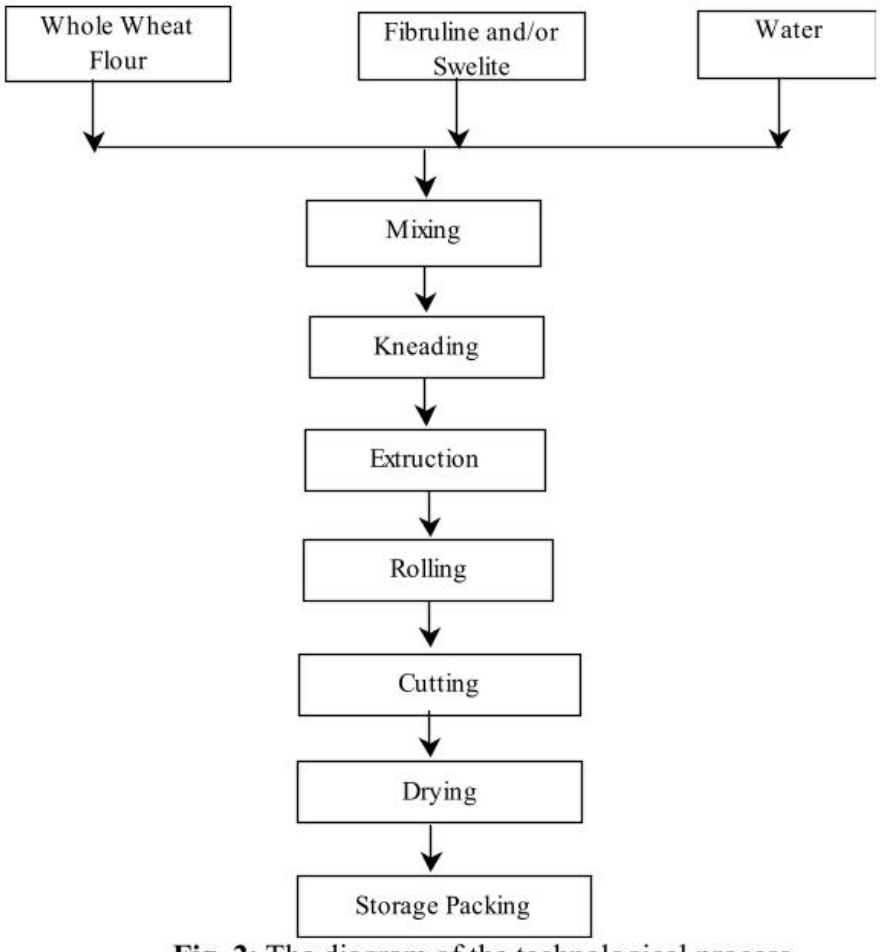

Fig. 2: The diagram of the technological process

The formulation and the technological parameters of the products are presented in table 3 and 4.

Table 3: Formulation of High Fiber Pasta with Inulin and Pea Fiber

Sample	No.1	No.2	No.3
Whole Wheat Flour	100	96,2	96,2
Fibruline	-	3,8	1,9
Swelite	-	-	1,9
Water	30	31	32,3

Table 4: Technological Parameters of the products

Sample	No.1	No.2	No.3
Dough mixing time, min	15	14	13
Flour temperature, ˚C	20	20,5	20
Water temperature, ˚C	18,5	18	18
Dough water content, %	29,7	31,9	32,9

Drying parameters for the samples according to the zone are: time (~8 hours), temperature (45-66 ˚C), relative humidity (60-70 %).

During the technological process the main differences between the tests are the following:

– the Fibruline and/or Swelite were previously mixed with water and then added in the mixing tank, because of their high swelling capacity which is immediately manifested,

– as consequence the mixing time is slightly decreased,

– the dough water content is increasing from no.1 to no.3 test due to a higher water capacity absorption as we can see also in the recipes,

– the higher water content of the dough is, the easier processability of the dough is observed; but the limit of hidratation is close, after that the handling becomes difficult.

An improvement of the dough sheet behavior is noticed: a better elasticity during the passage through the extrusion die and the rolling cylinders.

The physical chemical characteristics of final product are presented in table 5.

Table 5: Physical chemical characteristics of final product

Characteristics	No.1	No.2	No.3
Water content (%)	12,68	13,04	12,98
Protein content (%)	12,63	12,34	12,5
Acidity (degrees)	5,3	6	6,4
Broken resistance (g)	44,35	31,32	57,15

For water content, protein content and acidity the differences between tests are insignificant.

For broken resistance, inuline determines a decrease because it's high fiber and no protein contribution; and pea flour determines an increase due to the quality and quantity of its proteins.

After cooking characteristics (pasta behavior during and after boiling, using a standard method) is presented in table 6.

Table 6: After cooking characteristics of final product

Characteristics	No.1	No.2	No.3
Cooking time (min)	5-6	5	5
Volume increasing (%)	295	325	328

The aspect of the three pasta samples after boiling was: elastic, no sticky, the cooking water was slightly opalescent and with no sediment.

The sensory analyze indicates that test no.2 has the most increased elasticity and the added ingredients do not influence the cooked pasta stickiness.

The nutritional information of the final product is presented in table7.

Table 7: Nutritional information (per 100 g final product)

Nutritional information	No.1	No.2	No.3
Energy value Kcal KJ	 340 1441	 325 1378	 328 1391
Carbohydrates (g)	70,5	66,72	67,32
Protein (g)	12,63	12,34	12,5
Fat (g)	1,2	1,0	1,0
Dietary fiber (g)	3,5	7,9	6,2
Water content (%)	12,68	13,04	12,98

Conclusion

The new raw material proposed, the no.3 flour as against the no.1 flour has the following characteristics:

– is a high dietary fiber source (the fiber content is increased with 90%);

– an increased content of soluble fiber;

– a better water binding capacity (increasing of water absorption capacity with 5%).

We can observe that if 50% of the inulin content is replaced with pea flour, the rheological characteristics and all the technological properties are improved.

Compare to the reference without inulin and pea flour, no difficulties during dough processing were noticed even if the dough becomes slightly softer.

In terms of quality, the high fiber pasta has a slightly better elasticity and do not stick together after cooking.

Dietary fiber, for digestive comfort, can be declared as "high fiber" at minimum 6g TDF/100g product (TDF=total dietary fiber content); both no.2 and no.3 tests could be recommended as "high fiber" pasta.

Inulin is a bifidogenic or prebiotic ingredient at a daily consumption of 5 g/day approximately, that means a daily intake of 125 g whole wheat pasta with inulin could assure this request.

Inulin enhanced calcium absorption at a daily dose of 8 g inulin; 100 g of high fiber pasta could assure 50% of daily need.

Acknowledgements

The authors thanks to S.C. Enzymes & Derivates S.A. Romania.

References

AACC report (2001). The definition of dietary fibre. *Cereal foods World*, *46*, 112-126.

Eastwood, M. A., Morris, E. R. (1992). Physical Properties of Dietary Fiber that Influence Physiological Function: A Model for Polymers Along the Gastrointestinal Tract. *American Journal of Clinical Nutrition, 55*, 436-442.

Hill, M. J. (1998). Cereals, Dietary Fiber and Cancer. *Nutrition Research, 18*, 653-659.

Hond, E., Geypens, B., Ghoos, Y. (2000). Effect of high performance chicory inulin on constipation. *Nutr. Res.*, *20*, 731-736.

Menne, E., Guggenbuhl, N., Roberfroid, M. (2000). Chicory inulin hydro lysate has a prebiotic effect in humans. *J. Nutrition*, *130*, 1197-1199.

Modler, H. W. (1990). Bifidobacteria and their role in human health. *J. Int. Microbiol.*, *6*, 263-268.

Nzeusseu, A., Manicourt, D. H., Depresseux, G., Dienst, D., Devogelaer, J.P. (2003). Effect of inulin and oligofructose from chicory on bone mineral density in rats. *Journal of Bone and Mineral Research*, *18*, 296.

Trowell, H. C., Southgate, D. A. T., Wolever T. M. S., Leeds, A. R. (1976). Dietary fibre redefined. *Lancet*, *1*, 967.