# THE OPTIMIZATION OF THE RATIO OF POTENTIALLY ANTI-CARCINOGENIC VEGETABLE FIBRES IN CEREALS, FLOURS AND FARINACEOUS PRODUCTS IN THE NORTH-EAST OF ROMANIA

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**Abstract**

The increased contribution of vegetable fibres limits the indirect carcinogenic action of other nutrition principles. The research carried out in 17 world countries revealed that colon neoplasm is reversely proportionate to the use of cereals and their derivatives. The mechanisms via which the low use of vegetable fibres favours colon cancer are manifold: it decreases the speed of the intestinal transit, it increases the ratio of anaerobic microbial flora, it reduces the capacity to metabolise biliary acids. Therefore, the use of flours with high-degree of extraction, rich in insoluble fibres and containing less soluble fibres, facilitates consumer's digestion by producing an extended state of satiation; due to the reduction of the food intakes, the risk of obesity also decreases. Flours with a lower extraction degree and farinaceous products obtained from them negatively impact digestion by hydrating fibres, creating short-chain fatty acids in the colon, which ferment soluble fibres. This generates the low ratio of mineral salts and vitamins, the farinaceous products being food partially devitalised of valuable nutrients. The experiments carried out revealed the following results: the total vegetable fibres in wheat and wheat grits (for samples 1, 2, 3, 4, 5, 6) was between 10.6% and 44%, for rye and rye cake the values ranged from 11.5% to 11.73%, and for oat the value was 4.15%. For flours obtained from wheat, the total content of vegetable was: 3.25% for white wheat flour T650, 9.57% for whole-wheat flour. Regarding the types of white bread, the ratio of vegetable fibres was 2.51%, and, respectively, 8.47% for whole-wheat bread. The experiments conducted reveal that the sample 6, with grit granulation, has a high content of dietary fibres, namely 10.6%, of which non-cellulosic polysaccharides 6.27%, cellulose 3.48%, and lignin 0.85%, and that it can be used with good results in the technological process, having a hydration capacity of 84.46%. Therefore, by increasing the content of vegetable fibres from 3.25% in the white flour to 10.6% in the flour with dietary fibres obtained, we can optimise the quality of the farinaceous products with no added exogenous substances (food additives), and also improve the anti-carcinogenic potential of these farinaceous products. The research was conducted by using the resources of the processing company under the Research/consultancy agreement entitled "Research on the innovation of new farinaceous products rich in nutrients and recommended in the diets for preventing and fighting against certain metabolic disorders".

**Key words**: food safety, health, cereals, farinaceous products.

As early as 1971, doctor Burkitt in the UK claimed that dietary fibers play a part in the prevention of colon cancer by regulating the intestinal transit and stool volume. Numerous studies have confirmed that the consumption of whole grain cereals, in particular, is associated with a low number of intestinal cancers. (Mogoș, V. 1998)

The World Health Organization recommends that adults have a daily intake of 27-40 g of fibers, namely that is 15-22 g per day for 1,000 kcal they consume. For people who consume around 2,000-2,800 kcal, the recommended daily dose of fibers is 40-46 g. Total vegetarians have an average intake of 45-50 g of fibers per day, ovo-lacto vegetarians around 35 g, and omnivores or non-vegetarians only 10-15 g, which is too little. It is believed that the high intake of fibers specific of real vegetarians has a significant contribution with respect to the advantages of this type of diet.

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Dietary fibers refer to those parts of vegetal products that cannot be broken down by the enzymes in the human digestive tract. This definition traditionally included only non-starch polysaccharides (cellulose, hemicellulose, pectin, gums and mucilages) and lignin (which is not a glucid). Most experts also believe that oligosaccharides and starch are resistant substances (that are not digested and absorbed in the small intestine) and are a part of the total fibers.

There are two groups of dietary fibers with different functions:

-insoluble fibers, such as cellulose, lignin and certain hemicelluloses, that have a decisive influence on the volume and duration of the bowel movement and almost no effect on the intermediary metabolism or on the bacterial flora; absorbing a large quantity of water, cellulose increases the volume of the fecal bolus and lowers the concentration of carcinogens, which, by accelerating the transit, are eliminated faster, reducing the contact period with the intestinal mucosa;

- hydrosoluble fibers, such as pectin, certain hemicelluloses, gums and mucilages, can form stable gels. By slowing down the glucose absorption rate, it prevents postprandial hyperglycemia (spikes of the blood glucose levels immediately after eating) and the hyperinsulinemia it determines. Soluble hemicellulose plays an important part in reducing cholesterolemia.

All these fibers are indigestible polysaccharides that enter the large intestine, where they are fermented to various degrees by the bacteria in the colon. The fibers that ferment the least have the largest contribution to the fecal volume. The fibers that ferment the fastest are oligosaccharides, which can be found particularly in leguminous plants and cruciferous vegetables (cabbage, cauliflower, and broccoli).

Dietary fibers are part of the vegetal polysaccharides group that is not digested in the small intestine, some of them being degraded in the colon. Some dietary fibers that play structural roles in cereals and implicitly in groats and flours are insoluble in water (for instance: pectins - gums, mucilages and hemicelluloses). These fibers that are derived from cereals form gels that seal a part of the substances in the intestinal lumen, while the dietary fibers from fruits and vegetables play a part in stimulating the intestinal peristalsis (Mogoș, V. 2005).

Small glucid molecules, i.e. monosaccharides and disaccharides, are absorbed a lot faster in the intestine than large molecules such as starch. Only simple saccharides, i.e. those comprising a single molecule, can cross the intestinal mucosal barrier in order to pass into the blood circulation.

Complex glucids – or polysaccharides – must first be broken into simple saccharides during digestion. The ingestion of a simple saccharide, i.e. a monosaccharide, especially in the form of a liquid, increases the glycemia (the blood sugar concentration) a lot faster than the consumption of a slowly-digested sugar, a complex sugar or a polysaccharide sugar.

Both of the dietary fiber categories have different mechanisms that help them intervene in the anti-carcinogenic protection.

Reducing the intake of dietary fibers in favor of animal fats and proteins stimulates the development of a higher intestinal density for the bacteroid and bifidobacteria type of anaerobic bacteria, to the detriment of lactobacteria and streptococcus type of aerobes. Increasing the intake of anaerobes/aerobes fosters intestinal carcinogenesis. On the other hand, reducing the intake of cellulose-based products increases the intestinal pH, favoring the development of microbial flora (clostridia) that helps metabolize bile acids into carcinogenic products. Reducing the intake of dietary fibers increases the availability of bile acids for the microbial flora of the bowel (bile acids are no longer absorbed by the cellulose substrate and are eliminated through the feces), which can transform them in certain conditions into carcinogenic or co-carcinogenic substances. Fecal excretion of fats and nitrogenous substances is also reduced, which indirectly favors the carcinogenesis process.

White bread and flour products made using low extraction flours negatively influence digestion and one of its long term consequences is that nutrition determines the formation of short-chain fatty acids in the colon through the fermentation of the soluble fiber, the low ratio of mineral salts and vitamins. Thus, flour-based products become partially devitalized due to the spoiling of some important nutritious elements. The slower the intestinal transit, the longer the contact between carcinogenic substances and the intestinal wall, thus increasing the risk of developing a malignant degeneration.

Soluble fibers are those that can dissolve in water. When exposed to water, they create a gel and are decomposed after the fermentation produced by the bacteria in the colon. Their role is to increase the time lapse for the digestion of food and reduce blood cholesterol. Soluble vegetal fibers are: gums, pectins, certain hemicelluloses and mucilages.

Soluble fibers can be found in: fruits (particularly in apples and citrus fruits, as well as in others such as pears, blueberries and strawberries), cereals (barley or oats), oleaginous seeds (flax seeds), nuts, in vegetables (peas, lentils, chick peas, beans, soy, cabbage, salad, broccoli, artichokes, tomatoes, celery).(Shils Herman, 2000)

Insoluble fibers are the fibers that cannot be dissolved in water and form a so called "ballast". This ballast has a laxative function and helps flush out the toxins in the body and carcinogen substances. These are the types of insoluble fibers: cellulose, hemicellulose, and lignin.

Insoluble fibers can be found in whole grain cereals, wheat bran, fruits and vegetables (cauliflower, celery, raw carrots). However, this ballast is not at all good for ulcerated colons, because all it does is further irritate the intestinal walls and cause bleedings.

## MATERIAL AND METHOD

The content of soluble, insoluble and total fibers was determined using the gravimetric method (standard AACC 32-07), through the successive enzymatic hydrolysis of the sample of thermo stable -amylase, protease and amyloglucosidase for the purpose of removing the digestible material, followed by the precipitation of fiber polysaccharides. The residue obtained is dried and weighed, and its mass is corrected for the content of protein and ash. The equipments used are as follows: filtering crucibles (Bucher), calcinations kiln, heavy wall filtering flask, depression source (vacuum), high capacity vibrating water bath 20-24 l, analytical balance with a 0.1 mg weighing precision, stove that can be adjusted to 103°C and 130°C; PH-meter.

The reagents used are as follows: ethanol 95% (v/v), 78% solution (v/v), acetone, enzymes: thermo stable -amylase, protease, amyloglucosidase, deionized water, calcined celite, micro washing solution 2%, buffer solution MES/TRIS 0.5 m each, PH=8.2 at 24°C. The steps for making the determination were sequenced as follows: preparing the sample, enzymatic hydrolysis of the non-fiber components, determining the insoluble dietary fibers (IDF), determining the soluble dietary fibers (SDF), and determining the total dietary fibers (TDF). The results were calculated and expressed as follows: determining the content of soluble, insoluble and total fibers, which is expressed as a percentage of the analyzed sample. (Bordei Despina 2001). Regardless of the type of fibers that is analyzed, the calculation is carried out using the following formula:

$$\text{Dietary fibers \%} = \frac{\frac{R_1+R_2}{2} - P - A - RM}{\frac{m_1+m_2}{2}} x\ 100,$$

where the terms have the following meanings: R1 – mass of the residue obtained from m1, g; R2 – mass of the residue obtained from m2, g; m 1 – mass of the sample 1; m 2 – mass of the sample 2; P – protein mass from the R1,g residue; A – ash mass from the R2, g residue; RM – residue of the control sample;

$$RM = \frac{RN1+RM2}{2} - PM1 - AM\ 2, where:$$

RM1 – mass of the control sample 1 residue, RM2 – mass of the control sample 2 residue, PM1 – mass of the protein in RM1, AM2 – mass of the ash in RM2

## RESULTS AND DISCUSSIONS

*Figure 1* shows that in fraction no. 6 derived from grinding the cereals used for the study, the total share of vegetal fibers was 10.6% compared to 3.15% in white wheat flour and 9.51% in whole wheat flour. We observed a 1.09% increase of the fiber content in fraction no. 6. The percentage content of polysaccharides also increases from 2.52% to 7.88%, that is by 5.36%, cellulose increases by 1.34%, and lignin increases by 0.75%. Therefore, we noted an increase in the content of fibers, which translates into a significant quality improvement for the consumer health.

We noticed that fraction no. 6 takes us closer to the characteristics of the whole grain flour that is so popular nowadays for the purpose of whole grain bread consumption.

Similar properties can also be found in rye flakes, and that justifies the nutritionists' recommendation for increasing rye bread consumption.

From a technological point of view, the situation does not constitute a success because nowadays, in the north-eastern region of Romania and particularly in Iai, whole grain and rye bread production is carried out using food additives for the purpose of aerating the inside part and achieving a high level of porosity and developing a great volume for bread assortments.

For all these reasons, we recommend the direct use of fractions 1, 2, 3, 4, 5, 6 resulted from grinding the cereals and testing them for the purpose of obtaining bread products that are as healthy as possible.

*Figure 2* shows that fraction no. 6 has an 84.46% hydration capacity, the largest water absorption coefficient, which also helps achieve highly digestible bread products. Next in line are: fraction no. 4, with a 72.09% hydration capacity, T650 flour with 71.89% and fraction no. 5 with 70.42%. Our experimental results show that simple milling fractions resulted in various stages of gritting can absorb significant quantities of water, which constitutes both a technological advantage, and a consumer health benefit.

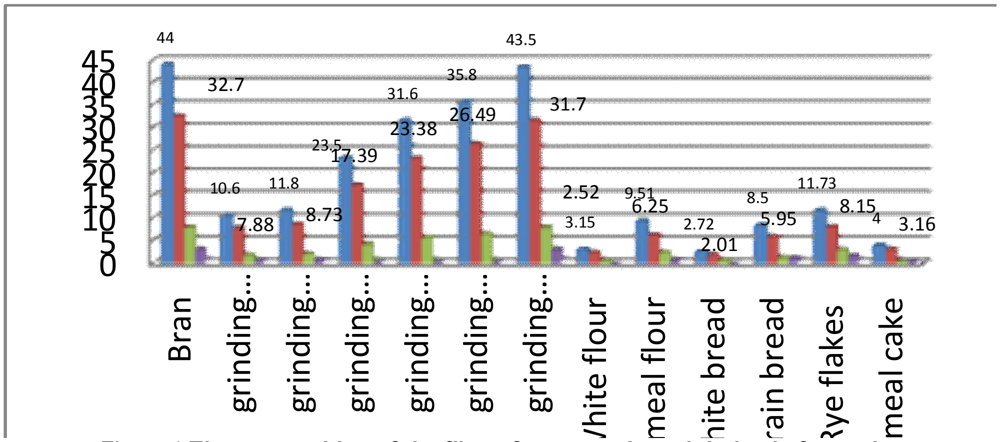


Figure 1 **The composition of the fibers from cereals and derived of cereals**

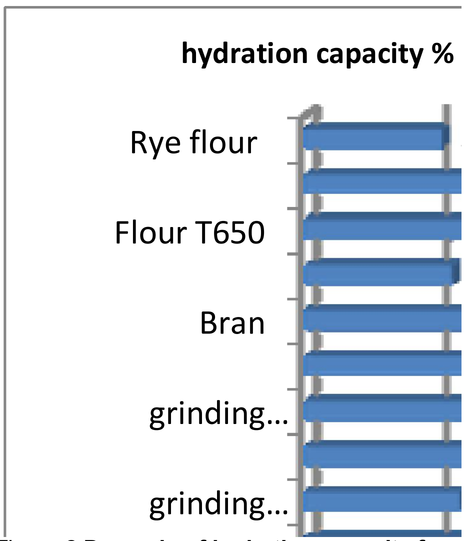


Figure 2 **Dynamic of hydration capacity from fraction 1, 2, 3, 4, 5, 6 and flours**

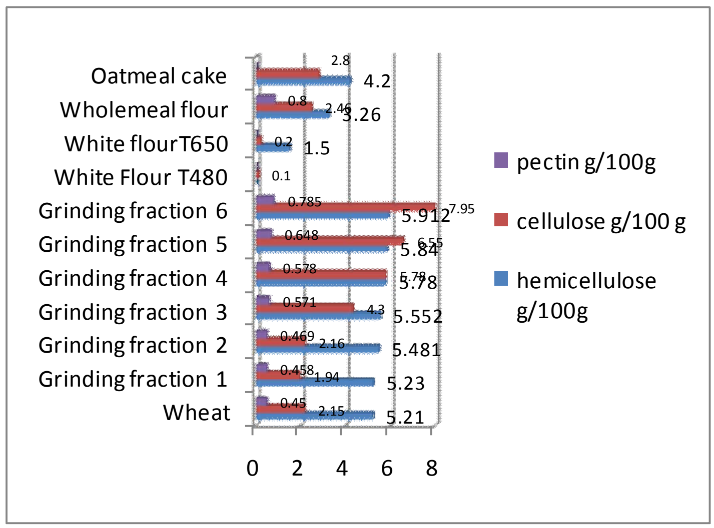


Figure 3 **Dynamic of polysaccharides with grindings benefits on consumer health**

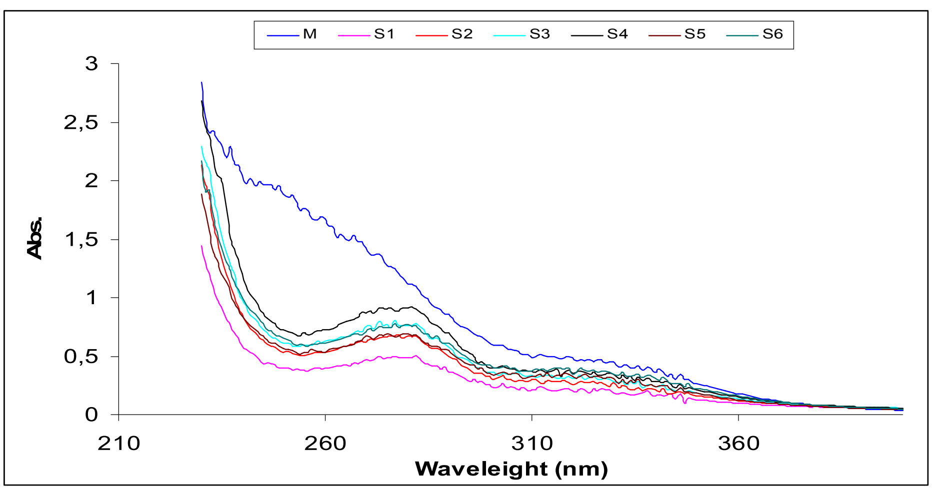


Figure 4 **Spectral Absorbtions in UV-VIS for grinding fractions 1-6 and wholemeal flour**

The hydration capacity analysis showed that fraction no. 6 can be successfully used for making highly digestible bread products recommended by nutrition researchers.

The dynamics of polysaccharides show that fraction no. 6 that resulted from the 6th gritting stage has a high content of cellulose, hemicellulose and pectin. Wheat, whole grain flour and oatcakes score much lower values – almost by half. This also shows the benefits that grit fraction no. 6 will provide when it is used as raw material for producing assortments of bread products with zero food additives (*figure 3*).

Fractions were also chromatographically analyzed tracking the content of essential amino acids. (*figure 4*) Samples 1-6 and the blank sample were subject to solid-liquid extraction: a) under the action of ultrasound (we used a digital bath ultrasonic 260 W)-MeOH solvent: solution 70%;

-temperature: 50 ° C;

-extraction time: 2 h;

b) under the action of microwave 3-5 minutes (use a microwave appliances LG)

-MeOH solvent: solution 70%; -power: 400W; -extraction time: 3 minutes. So, we can be seen from figure 5 extraction used for the best yield in extract (amino acids/proteins) has been obtained in the case of 4, followed by sample samples 3 and 6; then 2 and 5; and the lowest content in extract was recorded for sample 1.

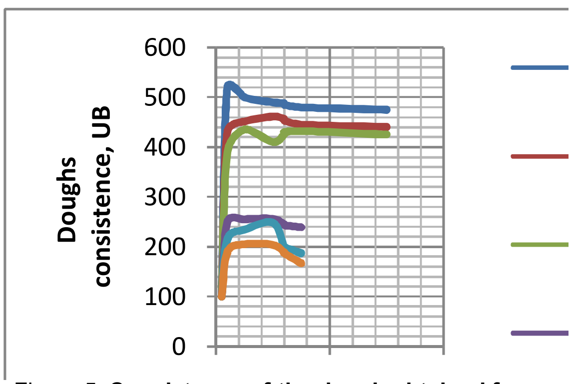


Figure 5 **Consistency of the dough obtained from bread-making flours**

Farinograph curves indicate that the T650 white flour currently used in making bread products has the best consistency – 550 UB. The next one is whole grain flour with 480 UB, and a surprisingly good result was obtained in fraction no. 6 during the gritting stage 6 with a 420 UB consistency, a superior result in comparison with the behavior of the dough obtained from rye flour with 200 UB, and the dough obtained from fractions no. 4 and 5 which scored 220 UB and 250 UB, respectively. The analysis of the technological recipes that were used for making the bread products indicated a (*figure 5*) great 84.46% hydration capacity in 100 kg of flour with fibers, which is also the best result in terms of consumption.

The following aspects derive from the description of the characteristics: the humidity of finished products has an upward variation from the white bread assortment to the rye bread assortment, with a maximum humidity in the assortment made from fraction no. 6. The white bread and whole grain bread assortments score high values in terms of porosity (66.7% and 60%), as well as in terms of elasticity (83% and 78%). The most important indicator, which is also very subjective and extremely well monitored by bread consumers, is volume. Thus, we notice here that bread with fibers has a volume of 175 $cm^3$/100 g of finished product, in comparison with 260 $cm^3$/100 g of finished product in white bread, which translates into a 32.7% decrease.

We can say that this volume in products with dietary fibers can only be accepted by the consumers by means of scientific nutrition programs that can help them understand the importance of bread quality in terms of its nutritive values and learn to give up the traditional habits in terms of consuming bread with a highly developed volume and increased porosity.

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## CONCLUSIONS

We recommend fraction 6 because it contains 7.88% soluble fibers (non-cellulose polysaccharides), while the quantity of insoluble vegetal fibers has 1.94% cellulose and 0.78% lignin, that is a very low share. The advantage recorded is precisely the increased quantity of soluble fibers in the raw material.

The experiments we carried out show a very large increase of insoluble fibers in fractions no. 1, 2, 3, 4, 5, and 6 (fraction no. 1: 7.95% cellulose, 3,12% lignin; fraction no. 2 – 6,55% cellulose, 0.28% lignin; fraction no. 3: 5.78% cellulose, 0.25% lignin; fraction no. 4: 4.3% cellulose, 0,18% lignin; fraction no. 5: 2.16% cellulose, 0.92% lignin.

In terms of the quantity of soluble vegetal fibers, favorable to a scientific nutrition, fractions no. 1, 2, 3, 4, 5, and 6 scored between 5.23 g/100g and 5.912 g/100 g of hemicellulose, between 1.94 and 7.95g/100 g of cellulose and between 0.485 and 0.785 g/100 g of pectin. Fraction no. 6 proved extremely benefic in terms of nutritional values, having optimal values of hemicellulose (5.912 g/100g), cellulose (7.95 g/100g), and pectin (0.785 g/100g).

4Extraction used for the best yield in extract (amino acids/proteins) has been obtained in the case of sample 4, followed by samples 3 and 6; then 2 and 5; and the lowest content in extract was recorded for sample 1.

The absorption analysis carried out on soluble fibers indicated that the best result was recorded in fraction no. 6, with a 4.99 absorption level and a 0.922 coefficient of undissolved fibers.

## ACKNOWLEGMENTS

This paper realized in the Research/consultancy agreement entitled **"**Research on the innovation of new farinaceous products rich in nutrients and recommended in the diets for preventing and fighting against certain metabolic disorders".

The fractions were chromatographically analyzed tracking the content of essential amino acids in laboratory of expertize from University „Vasile Alecsandri“ Bacău.

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