JAP&T
TPA-Timisoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2019, *25* (2), 46-50

Journal of Agroalimentary Processes and Technologies

Spent malt rootlets – A new potential ingredient for functional foods

Monica Bota[1], Simona Chiş[1], Carmen Pop[1], Adina Berbecea[2], Ersilia Alexa[3], Sevastiţa Muste[1]

[1]Faculty of Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine, 3-5 Mănăştur Street, 400372, Cluj–Napoca, Romania
[2]Faculty of Agriculture, Banat`s University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, 119 Calea Aradului Street, 300645, Timisoara Romania
[3]Faculty of Food Engineering, Banat`s University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, 119 Calea Aradului Street, 300645, Timisoara Romania

Abstract

The entire global scientific community has a real interest in seeking new technologies for the use of agro-industrial wastes in order to diminish the existing environmental problems. The greatest attention has been paid to the utilization of plant resources resulting from the by-products of the food industry. Malt rootlets ("Spent Malt Rootlets") are the end products from the malt industry, but with relatively limited use, being used as feed for animals. Rich in vitamin B, vitamin E, peptides, amino acids, fatty acids, dietary fibres, polyphenols, minerals, with a powerful antioxidant potential and economically cheap, studies have shown that applications using malt rootlets are an interesting option from the sensory, nutritional and economic point of view. Thus, these by-products contain, in appreciable quantities, biologically active compounds with high recovery potential.

The current study aims to expose additional nutritional and economic benefits of spent malt rootlets as a functional baking ingredient. In order to achieve this goal, analysis like moisture, protein, fibre, sugar, lipid, fat, ash, starch and salt amount were determined.

Keywords: malting, industrial wastes, spent malt rootlets, human nutrition, functional properties

1. Introduction

As regards the food industry wastes, the interest was mainly in the bioconversion of the dairy and beer (mainly brewery spent grains) wastes, as well as the processing of vegetable wastes [6].

Barley *(Hordeum vulgare)* represents a cereal belongings to the Poaceae family, ranks fourth globally in both quantity produced and cultivation area. It is conventionally utilized for animal fodder (~66%) or malted for brewing (~33%)and food applications (~2%) [17].

Solid beer wastes include brewery spent grains, spent malt rootletss and used brewer's yeast.

These wastes, like most industrial wastes, are rich in fibre and carbohydrates, proteins, vitamins and minerals [12].

The food, agricultural and forestry industries produce large volumes of wastes annually worldwide, causing a serious disposal problem. This is especially problematic in countries where the economy is largely based on agriculture and where the farming practice is very intensive. These wastes are rich in sugars, which due to their organic nature are easily assimilated by the micro-organisms. This makes such wastes very appropriate for their exploitation as raw materials in the production of industrially relevant compounds [12].

Corresponding author: *e-mail:* monica.bota@usamvlcuj.ro

The incorporation of barley into the human diet has received renewed attention owing to increased scientific evidence showing it to be an excellent source of dietary fibre, particularly β-glucan. β-Glucan is a soluble fibre that has US Food and Drug Administration (FDA)-approved health benefits,4 which include decreasing the risk of heart disease and being effective in lowering blood serum glucose levels. Barley rootlets primarily contribute protein, essential amino acids, healthy fats, polyphenols and minerals to the diet.

As such, the incorporation of rootlets into a staple food product such as bread could increase the protein content of poorer flours and thus increase the net nutritive value of final baked goods [17].

These specific components of beer industry wastes can be recovered by chemical or biological methods and then biotransformed into ingredients with high nutritional value for food, used in animal feed, the cosmetic or pharmaceutical industry.

Malt and barley have shown antioxidant properties mainly due to the presence of phenolic compounds, especially flavonoids and hydroxycinnamic acids [1].

Malt rootlets are germs appearing during the malting process of barley, which are separated before the brewing process and treated as a byproduct for animal feed. The production of an antioxidant extract from malt rootlets would add value to this byproduct and provide a potential new source of natural antioxidant [2,3].

Malt means barley softened, sprouted and then dried. The harvested product is called green malt and after drying, in special dryers, it is called malt [10].

The rootlets of malt are very fine grooves, yellowish-brown in color and are hygroscopic. Sprouted seeds have been commonly called germs, but malt germs are the product obtained by removing germs from malted barley. The germs are formed of acrospires and rootlets. Rootlets are a source of protein (about 25%) and dietary fiber (about 11.14%) [13].

Because malt rootlets have a bitter taste and are hygroscopic and increase the absorption of water when the malt is stored, they are removed by cleaning the malt from the rootlets immediately after the drying operation. From 100 kg of dry malt is obtained 3-5 kg of malt rootlets [8,9].

World malt production is estimated at 12 million tonnes, while rootlets represent 3% of malt.

The latter are generally incorporated into animal feed. The nutritive value depends on the protein quality and digestibility, which is affected by the nature of the protein and the non-protein constituents that modify digestion. Anti-nutritional factors such as phytic acid and polyphenol compounds are known to be present in cereals [14]. While phytic acid has mineral binding capacity, the polyphenol compounds decrease protein digestibility and reduce amino-acid availability. Germination reduces the phytic acid content of barley by about 25%. Polyphenol compounds content varied significantly among being lowest in spent malt rootlets (SMR) [13].

Malt roots are rich in vitamin B, especially in pantothenic acid and vitamin E, peptides, amino acids and proteins. Almost three quarters of the "raw protein" is the true protein and contains an adequate amount of lysine.

The current study aims to expose additional nutritional and economic benefits of spent malt rootlets as a functional baking ingredient.

2. Materials and Methods

The samples of spent malt rootlets (SMR) were supplied by SC.SOUFFLET AGRO ROMANIA S.R.L, whole spelt flour were purchased from specialty stores. SMR used in this work, was obtained as a by-product from the malting process using a spring barley variety, SEBASTIAN UKRAINE, 2016.

Drying the malt at 85ºC, in strong air steam is to eliminate the excess moisture and to stop or direct the biochemical and chemical transformations that occur and stabilize the malt composition. This step is followed by cooling malt at 20ºC to avoid enzyme inactivation and discoloration. Cleaning malt by the rootlets is doing immediately after drying according to [13].

SMR were passed through a mill feeder and fed after into a laboratory mill (Model3100, Perten Instruments) fitted with an 0.8 mm sieve and then homogenized by mixing. Starch content was determined using heat stable a-amylase (Sigma product No A-0164).

The nutritive value of SMR of this study, was investigated using: AOAC method for fibre, Kjeldahl method for protein, salt was calculate using: sodium x 2.5; sodium was analysed by AAS spectrometry, Weibull-Stoldt method for fat and enzymatic method for sugars, ash by calcination, moisture by oven-drying, starch using polarimetric Ewers method, macro and microelements using atomic absorbtion spectrometry [17].

Determination of micro and macroelements by atomic absorption spectrometry, is generally used for high sensitivity determinations of chemical elements using the absorption of optical radiation by free atoms in the gaseous state. Using this method, ppm concentrations (parts per million) can be determined and, unlike classical photometric methods, atomic absorption measurements are much more precise and do not require a high consumption of reagents, the analyzes being performed on aqueous or organic solutions.

Equipment and reagents: Hydrochloric acid, 20% solution (1: 4); Hydrochloric acid 6 mol / l; Nitric acid 0.1 mol/ l; Nitric acid (1: 9); Heat-adjustable electric furnace with ventilation; Analytical balance; Atomic absorption apparatus model VARIAN AA240FS; PC for reading the results.

Sample processing and mineralization

The samples to be analyzed, were ground until a homogeneous mass was obtained. Any impurities should be excluded during processing. In a porcelain crucible weigh about 3 g of the sample. The flame is pre-calcined and after the pre-calcination is completed, the crucible is placed in a calcination oven. Its temperature rises gradually until it reaches 550-600ºC, where it is maintained until the calcination is completed, for about 10-16 hours.

After the completion of this step, the crucible is cooled in the dryer, 5 ml of hydrochloric acid 6 mol / l is added, to evaporate the acid in the sand bath, dissolving the residue in 0,1 mol / l nitric acid (10 ml to 30 ml).

The control is performed using deionized water, following the same procedure.

Spectrophotometric determination

Includes the following steps: a) Opening the atomic absorption apparatus; b) Actuation of the cathode lamp corresponding to the elements to be analyzed; c) Adjusting the operational parameters (wavelength, sensitivity, etc.); d) Compressor coupling and acetylene and air flow regulation; e) Ignition of the flame and adjustment of the height of the burner; f) Adjusting the deionized water zero. The standard curve is established by the absorption of at least 3 standard working solutions of different concentration. After establishing the curve for each chemical element, it is followed by reading and calculating each element proposed for analysis.

The metal content (E) is expressed in parts per million - ppm - (mg / kg).

$$E = \frac{C \times V \times 1000}{M \times 1000*} \quad (1)$$

where:

E - the name of the element; C - the quantity taken from the standard curve, in micrograms; V - total volume of the sample solution (ml); M - the amount of sample taken in grams; 1000 - content ratio factor to 1000 g (1 kg); 1000 * - the factor of transformation of micrograms into milligrams.

3.Result and discussions

Table 1 presents the chemical composition of spent malt rootlets compared with whole spelt flour. The chemical composition of malt rootlets is variable according to the variety of barley , the malting process, the conditions and the duration of storage but always presenting a high content of fibre, protein and minerals. A level of 5% to 10% added spent malt rootlets, can produce fortified products, comparable to od higher that those of whole spelt flour from a dietary point of view [11].

As the results shows SMR is a material rich in dietary fibres and proteins, similar results are expected following its incorporation into pastry products. Salama at all., 1999, determinate the fibre content of malt rootlets, which were introduced into a different percentages, in two types of bread, biscuits and sausages. Substitution levels of 5% and 10% gave a good bread, with high protein and fibre content. Biscuits with 15% rootlets were acceptable but sensory qualities were affected [15, 16].

In accordance with the data from the literature, the malt rootlets having a fiber content of 40.3%, almost four times higher compared to the whole spelt flour. As showed in table 1, the fibre content is similar with the result reported by Waters et all., 2013 [17].

Regarding the starch content of whole spelt flour compared to that of spent malt rootlets, it is found that they contain more starch due to the degree of extraction.

Following the studies on the chemical composition of malt rootlets it was concluded that they have a fat content of 3% of which saturated fatty acids (% of total lipids) 24.12%, compounds with multiple benefits on the human body. This result is in agreement with other authors [13].

Specifically, the biofortification of pastry products with lysine is topical for nutrition, in addition the incorporation of spent malt rootlets improves the content of β-glucans which, from a medical point of view, increases saturation and positively influences blood glucose, insulin and cholesterol. The use of spent malt rootlets as a food ingredient is aimed to the consumers looking for healthy foods thus creating a potential market for this product [12].

According to Salama et all., 1999, spent malt rootlets have a high water, oil and emulsification ability, with high calcium content (19-9 gkg^{-1}) and high protein content (31-9%) which gives this by-product a good nutritional high value (low in phytic acid and rich in polyphenols). The higher protein content could be justified by various factors like the soil fertilization, the soil chemical composition, the variety of barley and the harvest date, as well as the quantification method, could explain such a difference [15].

The recommended intake of dietary fibre is around 30 g/day of which half must come from cereals. This is why foods rich in fibre are mostly cereals, and it is important that cereals products are consumed in large quantities [7].

Spent malt rootlets have a mineral content up to seven times higher than whole spelt flour. Malt rootlets are considered a nutritionally valuable by-product due to their high protein content but also due to their balance in the essential fatty acids content. Many of the basic substances are present in malt rootlets extracts, including choline, betaine, thiamine, carcinid. Malt rooletst extracts offer a rich source of growth factors for microorganisms, such as rootstocks, *Eremothecium ashbyi* mold, which is used to produce riboflavin [4,5].

According to Waters et all., 2013, further benefits of using cheap, readily available rootlets in bread making or as a general food ingredient can be expected [17]. For example, the increased demand for creating a new market for high-nutrition, low-value rootlets could equate to a higher price for this by-product through its re-categorization as a co-product. Rootlets are a generous source of essential and non-essential aminoacids, which should encourage their incorporation into cereal goods for the lacto-vegetarian and vegan markets.

Table 1. Comparative chemical composition of whole spelt flour and spent malt rootlets (% dw)

	Whole spelt flour	**Spent malt rootlets**
Moisture, %	14.27	4.2
Protein, %	29	35.5
Fiber, %	14.9	40.3
Starch, %	74.9	15.3
Sugar, %	6.8	3.5
Fat, %	4	3
Ash, %	0.64	7.7
Salt, %	0.27	0.41

Table 2. Micro and macronutrients content of spent malt rootlets and whole spelta flour

g/100 g	K	P	Cu	Zn	Fe	Mn	Ca	Mg
Spent malt rootlets	2.77^a	1.65^a	0.005^a	0.003^a	0.009^b	0.009^b	3.03^a	1.62^a
Whole spelta flour	1.59^b	0.54^b	0.003^b	0.027^b	0.025^a	0.012^a	0.196^b	1.062^b

*small letters means the signicantely difference between spent malt rootlets and whole spelta flour, for the same element (p<0.05)

Comparing the whole wheat flour and malt roots from the point of view of the mineral content, we can see statistically significant differences regarding the following minerals: K, P, Cu, Zn, Fe, Mn, Ca, Mg (table 2).

The results obtained regarding micro and macromineral content, are similar to those reported by Waters et al., 2013, for malt rootlets [17] and by Becerra et al.,2010 [18] for whole wheat flour.

4. Conclusions

Scientific research has revealed that SMR has highly desirable nutritional characteristics from a human dietary standpoint. Typical SMR compositions vary but always include high levels of dietary fiber and protein as well as appreciable levels of minerals, vitamins and lipids. These quality characteristics, in addition to its low cost and high levels of availability, make SMR appropriate as a functional food ingredient.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

References

1. Anca Fărcaș, 2014, Cercetări privind identificarea și valorificarea unor compuși biologic activi din biomasa rezultată ca subprodus la fabricarea berii, USAMV CLUJ-NAPOCA
2. Barbosa P., L. Bilbao, A. Vilches, P. et al, 2014b, Brewery wastes as a apotential source of phenolic compundsș optimisation of the extraction process and evaluation of antioxidant and antimicrobial activities.
3. Barbosa P., L. Poscheville, A. Angulo et. al, 2013, Fractionation and purification of bioactive compound obtained from a brewery waste stream, *Biomedical research international.*
4. Bonnely, S. Peyrat-Maillard, M-N. Rondini, L.Masy, D. Berset C., Antioxidant activity of malt rootlets extract, *Journal of Agricultural and Food Chemistry*, **2000**
5. Briggs D., Boulton C.A., Peter A., Stevens R., *Brewing Science and Practice*, CRC Press, *2004*
6. Briggs D.E., Hough J.S., Steven S.R., Young T.W., *Malting and breweing science* vol.1, Malts and sweet wort, Ed.Kuuwer Academic, Plenum Publishers, **1996**
7. Buschke N., Schafer R., Wittmann J., Metabolic engineering of industrial platform microorganisms for biorefinery application-optimization of substrate spectrum and process robustress by rational and evolutive strategies, Bioresouce Technology, **2013**, *135*, 544-554
8. Costin G.M., Rodica Segal, *Alimente funcționale.Alimentele și sănătatea*, Ed. Academica, București, **1999**
9. Modoran D., *Procesarea industrial a malțului*, Editura Academicpress, Cluj-Napoca, ISBN 973-7950-34-, **2003**
10. Mudura, Elena., *Tehnologia malţului şi berii*, Editura Mega, Cluj-Napoca, ISBN 978-606-543-419-, **2003**
11. Peyrat-Maillard, Bonnely M., Rondini L., Berset C., Effect of vitamin C and vitamin E on the antioxidant activity of malt rootlets extract, *Lebensm.-Wiss. u.-Technol*., **2001**, *34*, 176-182
12. Rondini L., Antioxidant activity of malt rootlet extracts, *Journal of Agricultural and Chemistry*, **2016**
13. Salama A.R.A, Eh-Saha, M.A. Mesallam, A.S. Shehata, M.E.T.A, 1997, The chemical composition, the nutritive value and the functional properties of malt sprout and its components, *Journal of the Science Food and Agriculture*, **1997**, *75*, 50-56
14. Salama A.R.A, Eh-Saha, Mesallam M.A., Shehata A.S., Evaluation of the quality of bread, biscuits and butcher's sausage supplemented with rootlets of malt sprouts, *Narhrung-Food*, **1997**, *41*(4), 228-231
15. Socaci, S.A., Socaciu, C., Mureşan, C., Fărcaş, A., Tofană, M., Vicaş, S., Pintea, A., Chemometric Discrimination of Different Tomato Cultivars Based on Their Volatile Fingerprint in Relation to Lycopene and Total Phenolics Content, *Phytochem. Anal.*, **2014**, *25*(2), 161–169.
16. Susana Rodriguez – Cotto, Exploatation of biological wastes for the production of value-added products under solid-state fermentation conditions, *Biotechnology Journal*, **2008**, 859-870
17. Waters Deborah, Arendt E., Jacob F., Zannini E., Wheat bread biofortification with rootlets, a malting by-product, *Journal of the Science of Food and Agriculture*, **2013**
18. Becerra F.G., Erdem H., Yazici A., Tutus Y., Torun B., Ozturk L., Cakmak I., Grain concentrations of protein and mineral nutrients in a large collection of spelt wheat grown under different environments, *Journal of Cereal Science*, **2010**, *52*(3), 342-349, https://doi.org/10.1016/j.jcs.2010.05.003