

The Study of Amine Nitrogen in Malt Sprouts Used as a Food Supplement

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ABSTRACT

Taking care of health and harmonious development of the body are important aspects of lifestyle in modern society. Many functional products contribute to the prevention of various diseases. The raw material base for these products is most often the products of primary or advanced processing of agricultural raw materials: bread, yoghurts, drinks. This study offers to use similar raw materials – secondary products of food production. They are low in price and predominantly represent waste, which poses a significant problem for food enterprises. The study was conducted to determine the content of amine nitrogen in the growths of barley, rye malt and malt from triticale. The results have shown that the duration of germination and drying modes of malt significantly affect the preservation of amine nitrogen. For instance, the loss of amine nitrogen during intense heat treatment can reach 18–20 %. It was also found that aqueous extraction of amine nitrogen is active at a temperature from 60 to 80 °C. The necessary and sufficient time for a full extraction was 80–90 minutes. The results of the study have shown that malt sprouts are a functional ingredient for food fortification, e.g. snacks. According to the experiment results, there have been developed the recipe and technology of grain bars enriched with malt sprouts.

Keywords: malt sprouts, functional ingredient, amine nitrogen, food supplement

1. INTRODUCTION

The development of food and processing industry of any state is associated with the transition to resource-saving technologies. This process turns the waste of primary production into secondary raw materials.

Solid and liquid waste from fermentation plants can be considered as secondary material resources [1]. Malt sprouts are a valuable secondary material resource of malt production [2, 3]. In Russia, 1.25 million tons of malt was produced in 2018. The weight of malt sprouts depends significantly on the technology of malting, but the average weight of sprouts is 5 % by weight of malt. Thus, in Russia, the total weight of malt sprouts is about 62.5 thousand tons per year.

Malt sprouts contain up to 25 % of the nutrients of the feedstock. Malt sprouts have nutritional value. Therefore, the study of malt sprouts as a secondary raw material resource is relevant. Malt sprouts contain a large amount of macro- and micronutrients [4, 5]. Malt sprouts give amino acids, enzymes, vitamins, growth stimulators. Therefore, they can be used in the feed industry, food industry, microbiological industry and pharmaceutical industry. Rutin, chlorogenic and ellagic acids have been identified in the malt sprouts. This process determines the antioxidant properties of malt sprouts [6]. Qualitative and quantitative studies of tocopherols and tocotrienols revealed the presence of α -, β - γ vitamins in malt and malt bran [7].

Malt sprouts are used as an extract and powder. Malt sprouts are used as a component of nutrient media for the cultivation of microorganisms in the production of medical and veterinary preparations [8], in alcohol and yeast production [9].

Production strains–producers need not only a full and well-selected component composition of enzymatic nutrient media but also a balanced ratio of these substances. This fact increases the quantity and quality of the target product. The use of malt sprouts as a culture medium has been shown to be an innovative growing method for three strains of *Lactobacillus salivarius* [10].

Also, the malt sprouts can be used for growing fodder yeast and mould cultures in the production of vitamins and organic acids, enzyme preparations, feed antibiotics [11, 12].

Proteins are vital in the feed of farm animals. Organic substances in malt sprouts average 89 %, including more proteins (21–25 %) and carbohydrates (46 %). Therefore, this is of great interest as a feed [13]. Malt sprouts have been used as an economical source of protein and energy in mixed foods of dairy or meat cows, cattle, horses, pigs and poultry [14, 15].

The high nutritional value of the malt shoots makes it possible to use them for the production of enriched and functional foods. The introduction of natural sources of vitamins, micro- and macronutrients from recycled materials into traditional and specialized foods can compensate for the imbalance in the diet of modern man.

This diet is essential for an active lifestyle. Recipes of curd products with powder from sprouts of malt have already been compiled [16, 17].

People eat many baking products in Russia. The development of recipes and technologies for baking products with functional components is instrumental. The mineral and vitamin component of bakery products is significant for every person.

Compositions of bread with powder of barley malt sprouts were compiled [18]. Test laboratory samples contained 1, 2, 3 % of barley malt powder. Physicochemical studies of bread were performed. The quality of bread depends significantly on the amount of barley malt powder. The best bread has 1 % barley malt powder. The production of bread with the addition of selenium-enriched soy malt to the leaven increased the activity of yeast and lactic acid bacteria and, as a result, improved the quality of wheat bread [19]. The possibility of using malt sprouts and extracts from them in technologies for producing melanoidin preparations that can be used for flavouring food products is shown [20]. A promising direction for the use of malted sprouts is the fact that they contain betaine, the concentration of which is up to 10 mg/g. Betaine has a beneficial effect in some human diseases, such as obesity, diabetes, cancer and Alzheimer's disease [21, 22].

A particular biological and physiological value in sprouts is free amine nitrogen, which is well absorbed by all living organisms and is of great interest to industry. The use of malt sprouts in food production technology allows not only increasing the nutritional value of finished products but also reducing their cost. In a competitive market, this is undoubtedly beneficial for both the consumer and the manufacturer [23].

2. MATERIALS AND METHODS

2.1. Material

Malt sprouts barley, malt sprouts rye and malt sprouts triticale were the object of the study.

2.2. The methodology of the study

Obtaining powder from malt sprouts. Soaking of grain crops was carried out in order to increase the grain humidity to 40–46 %. Germination took place at a temperature of 15–20 °C with constant aeration. Malt drying was carried out in a drying Cabinet at a temperature of 80 °C to obtain dried raw materials with a humidity of 4 %. Separated after drying malt sprouts were ground to a powdery state.

2.3. Determination of amine nitrogen

The determination of amine nitrogen was carried out by the copper method, which is based on the ability of most amino acids and peptides to form soluble complex compounds with copper. Excess copper is titrated. This excess is equivalent to amine nitrogen. Then this excess is converted by acetic acid into the salt of acetic acid. After determined by iodine titration.

In a volumetric flask with a capacity of 100 cm³, 10 cm³ of clear wort obtained from malt sprouts is placed, 3–4 drops of thymolphthalein and 1 n. sodium hydroxide solution is added until pale blue colouring. When stirring, add 30 cm³ suspension of phosphoric acid copper and bring to the mark with distilled water. The mixture is filtered through a paper filter after thorough mixing. Then 10 cm³ of the clear filtrate is acidified with 0.5 cm³ of 80 % acetic acid, and 1 g of potassium iodide is added to it. After stirring, the liberated iodine is titrated 0.01 n – sodium thiosulfate solution. One or two drops of a starch solution are added to this. Titration is completed by bleaching the solution from one drop of sodium thiosulfate. The amount of sodium thiosulfate titrated multiplied by 0.28 gives the amine nitrogen content of 10 cm³ of the filtrate. This result corresponds to 2 cm³ of the wort, taking into account the dilution, based on the fact that 1 cm³ of 0.01 n. the solution of thiosulfate corresponds to 0.28 g of nitrogen.

The formula calculates the amount of amine nitrogen (N, mg) in 100 cm³ wort:

$$N = a \cdot 0.28 \cdot 5 \cdot 10 \quad (1)$$

a – amount solution of sodium thiosulfate, which went to titrate the released iodine, cm³; 5 and 10 – conversion coefficients from 2 cm³ to 100 cm³.

For determining the amine nitrogen in 100 g of the extract, the calculation is carried out according to the formula:

$$N_1 = \frac{N \cdot 100}{d \cdot e} \quad (2)$$

N – the amount of amine nitrogen in 100 cm³ of the wort, mg; d – relative density of the wort; e – a mass fraction of dry substances in the wort, %.

3. DISCUSSION OF THE RESULTS

This article provides a brief overview of possible ways to use such waste malt production as sprouts. They are formed when sprouting malt, dried with it, and then separated by individual machines.

The weight of the malt sprouts significantly depends on the technology, but it can be averaged that their weight is 4–5 % by weight of the finished malt. The total weight of the malt produced for the needs of the food industry is considerable. If the malt shoots are not used, then it must be stored and disposed of, which is expensive. Therefore,

sprout sprouts are a valuable secondary resource. This fact reduces the cost of the finished malt.

Malt sprouts of any cereals are formed during production, and their chemical composition differs depending on the nature of the raw materials used.

Studies were conducted to determine the content of amine nitrogen during the growth of barley malt, rye malt and triticale malt. Natural drying and drying were carried out in three modes to determine the amount of soluble nitrogenous substances:

- The first sample was subjected to an Easy short drying for 6 h at a temperature of 50 °C with a smooth transition to temperature drying, lasting 8 h at a temperature of 80 °C. We received light malt with a humidity of 3 %;

- For the second sample, a long-term drying was applied for 10 h at a temperature of 50 °C with a smooth temperature transition to a 5 h drying at a temperature of 95 °C. We received dark malt. Malt obtained with low colour indicators and humidity of 2.2 %;
- The third sample was also subjected to prolonged drying at a temperature of 50 °C for 10 h with a smooth transition to drying (105 °C for 4 h). We received dark malt with a higher colour index and humidity of 1.5 %.

The graphic image of malt drying modes is shown in Figure 1.

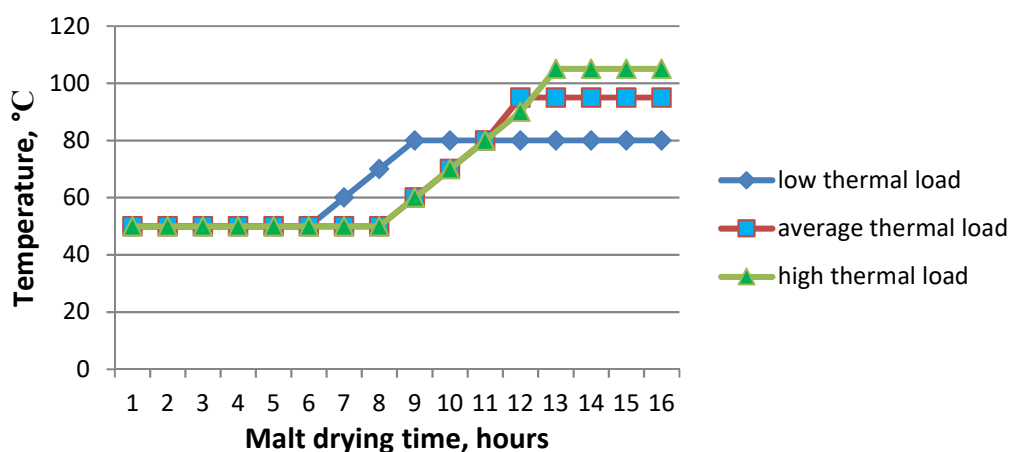


Figure 1 The mode of drying malt

After drying, all the samples were separated sprouts that were necessary for the study. To determine the α -amine nitrogen, powdered samples of malt sprouts were subjected to water extraction. Then, nitrogen was determined in the extract by the copper method.

It was found that the aqueous extraction of amine nitrogen in rye malt is effective at a temperature of 60 °C to 80 °C. The necessary and sufficient time for full extraction was 80–90 min (Figure 2). In samples from barley malt and triticale malt, these trends have been preserved.

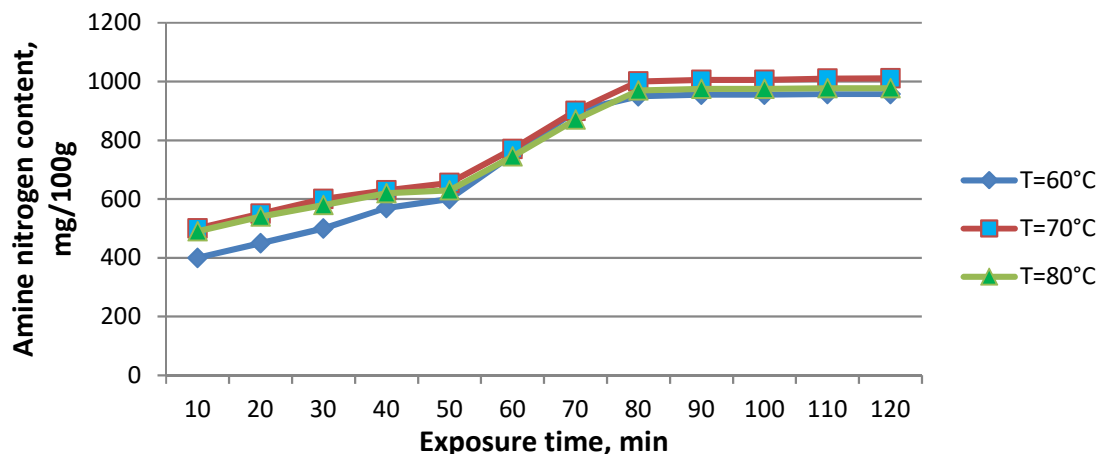


Figure 2. The dependence of the content of amine nitrogen on time and exposure temperature on the example of rye malt

Amine nitrogen in the samples ranged from 818 mg/100 g to 1410 mg/100 g. It depends on the technology of malting and grain. It was found that the duration of germination and drying modes of malt significantly affect the preservation of amine nitrogen. For example, the loss of amine nitrogen during intensive heat

treatment can reach 18–20 %. Data on the content of amine nitrogen in malt sprouts of different cereals under different treatment modes during drying are presented in Table 1. As a comparison, data on the content of amine nitrogen in light barley malt are given.

Table 1 Amine nitrogen content in the studied samples of malt sprouts, mg/100 g of extract

Processing mode	Amino nitrogen in the shoots of barley malt, (mg/100g)	Amino nitrogen in the shoots of rye malt (mg/100g)	Amino nitrogen in the seedlings of malt from triticale (mg/100g)	Amino nitrogen in the barley malt (mg/100g)
Short drying	962	1000	1410	200
Long drying	945	985	1390	160
Long drying with a high thermal load	818	837	1156	135

The high content of amino nitrogen in malt sprouts of different cereals allowed predicting their use in products where there is a lack of this component, as well as in specialized and functional food products. For example, nutrition for athletes and people with increased physical activity.

Our study proved that sprouts of malt are an excellent ingredient for enriching snacks. We experimentally got the

result. We have developed recipes and technologies for cereal bars enriched with malt sprouts.

Four samples of granola bars were prepared: control, with one per cent malt sprouts, with five per cent malt sprouts, and with ten per cent malt sprouts. The recipe used a powder from malt rye sprouts. Granola bars also included oatmeal, honey, peanut butter, sunflower seeds, almonds, raisins, dried cherries, and sesame seeds. Samples of finished products are shown in Figure 3.

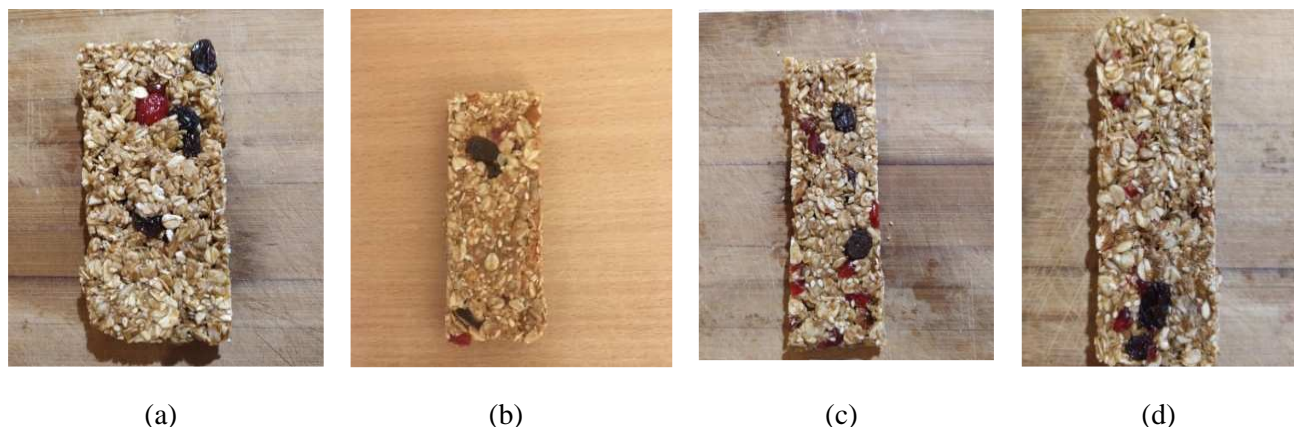


Figure 3 Samples of granola bars: (a) – control sample; (b) – sample with 1 % malt sprouts; (c) – sample with 5 % malt sprouts; (d) – sample with 10 % malt sprouts.

For assessing the effect of malt sprout powder on the quality of granola bars, laboratory tests were carried out in which 1 %, 5 % and 10 % of malt sprout powder were added to the recipe of the bars.

When adding 1 % of the powder from malt sprouts to the recipe, no changes were observed in the appearance, taste and smell of the finished product; when adding 5 % of the powder from malt sprouts, the combination of taste, colour and smell of muesli bars was the best, improving the organoleptic characteristics of the product.

When adding 10 % of the powder from malt sprouts appeared real grassy taste, the smell became more pronounced.

Thus, the optimal dose of malt sprout powder for granola bars was established – 5 %. The energy value of a sample of bars with a five per cent content of malt sprout powder was 414 kcal/100g.

4. CONCLUSION

Our results prove that malt sprouts are not waste from malt production. Malt sprouts are a valuable resource. Malt sprouts contain amine nitrogen. Amine nitrogen is an essential supplier of organically bound nitrogen to humans.

The amount of amine nitrogen in malt sprouts significantly depends on the grain used and malt drying modes. We found that the best results are given by cereals such as rye and triticale when using gentle drying temperature modes with short drying and super short drying.

Adding malt sprouts enrich granola bars with easily digestible amine nitrogen, which useful for people who lead an active lifestyle and are engaged in mental activity.

Granola bars with the addition of malt sprouts in an amount of 5 % are well stored and high-calorie, which makes them a convenient and useful snack.

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