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Incorporating single cell proteins in the diet of IBD patients

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1. Summary

Worldwide, and also in Hungary, more and more patients are diagnosed with inflammatory bowel disease (IBD) each year. In the case of IBD patients, to supplement a normal diet, alternative solutions, such as, for example, the dietary use of single cell proteins intended to be examined by us are required. Ensuring the proper nutrition and liquid supply of the human body is one of the major tasks of modern food science. By using state-of-the-art scientific knowledge and diagnostic methods, the energy requirement of people with increased energy and protein needs can be determined as a function of their body weight, and the production processes of foods should be realized with this information in mind.

In our research, single cell proteins (SCP) have been produced in a yeast culture grown on high sugar content culture media, including their nutritional evaluation. Possibilities for incorporating SCP in the diet of IBD patients have also been investigated. With our research results, we would like to provide assistance to specialists in food science and those in nutrition science contributing to food production.

2. Introduction and objectives

The number if inflammatory bowel disease cases is constantly increasing worldwide **[12]**. The chronic inflammatory disease of the gastrointestinal tract includes Crohn's disease (CD) and ulcerative colitis (UC). These diseases have now become a major health problem. Their treatment has advanced significantly with the introduction and optimization of targeted biological therapies and the application of special drugs (5-ASA products) **[15], [16]**. The cause of the disease is not yet known by science, only remission can be achieved **[9]**. In addition to targeted gastroenterological treatment and psychiatric support, dietary nutrition assistance and the application of a diet are recommended. The metabolism of individuals suffering from the diseases is characterized by an increased loss of energy and proteins, as a result of which an energy and protein-rich diet is recommended. Dietary suggestions for this are already known, and the effects of the proposed diet have already been studied **[10]**. However, there are still no available literature sources on the applicability of single cell proteins to supplement the diet. In the course of our previous research, the production possibilities and the yield of the end product were investigated **[14], [13]**. Continuing our research work, the applicability of SCPs to supplement a protein-rich diet in the case of IBD patients was determined, providing assistance to professionals in the fields of food science, medicine and nutrition science.

3. Literature review

3.1. Production of single cell proteins

The rise of conventional biotechnology led to the development of not only alcohol production **[6]**, but also of the production technology of single cell proteins (SCP) **[7]**. The cell mass produced by fermentation is biomass produced most commonly by the utilization of yeast, often by recycling food industry by-products. In addition to using them as feed additives, SCPs have also been often incorporated in the human diet in order to meet increasing food and protein needs **[1]**. In addition to the useful, physiologically active ingredients of these products, possibilities of supplementing them with micro nutrients and vitamins are also outstanding, and have been studied in several research projects **[3], [8], [17]**. In addition to the technological solutions of the enrichment process, the digestability of such foods have to be

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ensured as well. Digestability can be improved in the manufacturing process by the mechanical disruption of the wall of the cells containing the single cell proteins **[1]**. SCP production often uses food industry by-products whose recycling is also beneficial from an environmental protection point of view, but at the same time, their useful substance content promotes the development of yeast.

3.2. Nutritional values of single cell proteins

SCPs to be utilized are mainly significant because of their protein content. Of their amino acid content, cysteine and methionine are outstanding. B vitamins make up most of their vitamin content. The vitamin content of the different products can be enriched with premixes **[18]**. Among B vitamins, vitamin B_{12} supplementation is of great importance in the treatment of anemia caused by the occurrence of inflammatory bowel disease **[2]**. With SCP-based products, higher doses of vitamin B_{12} can be applied. During production, beneficial micronutrients are also enriched in yeast, which together with the unsaturated fatty acid content of the products can also help improve the condition of the patients **[11]**.

3.3. Diet of IBD patients

The symptomatic treatment of inflammatory bowel diseases if multifold, it ranges from medication, through maintaining normal body weight to the supplementation of micro- and macronutrients **[21]**. IBD symptoms often include weight loss, resulting not only in a decreased body weight, but also in a loss of useful nutrients. During treatment, following the sorting out of the water and salt balance, the most important goal is to use the diet to relieve the inflammatory processes of the intestinal tract and to restore and maintain normal body weight **[19]**. In order to do so, adherence to a special diet is required **[5]**. To supplement the diet, complementary solutions, such as the addition of formulas are often used. Additionally, the incorporation in the diet of single cell protein products, the subject of this research can also be useful because of their nutritional values **[12]**. Their usefulness and practical incorporation in the diet can serve as an excellent research topic that will help professionals in both manufacturing and therapeutic processes.

4. Materials and methods

SCP production fermentation experiments to supplement the diet of IBD patients were carried out at the Department of Food Science of the Faculty of Agricultural and Food Science of Széchenyi István University, using a Biostat A plus fermentor with batch fermentation. Assistance in the protein content determination of the samples taken during the fermentations was provided by the Department of Water and Environmental Sciences of Széchenyi István University. Taking into account the literature analysis and economic calculations, yeast strain *Saccharomyces cerevisiae* NCAIM Y.00200 was selected, which was obtained from the National Collection of Agricultural and Industrial Microorganisms (Budapest) in a vacuum-sealed, double ampoule, freeze-dried form. Following the preparation of pure cultures, their morphological analysis was also carried out. The inoculum used during the fermentations was prepared by introducing 10^6 cells/cm^3 yeast into 50 cm^3 of a 6.5 g/l NaCl saline solution. Since molasses are used as a culture media during the fermentation process in most of the literature sources analyzed by us, molasses were also used in our experiments, the source of which was Gyor Distillery Co. Ltd. Due to its high sugar content, the culture media was diluted threefold, of which 2 dm^3 was used. The parameters selected for the optimization process of the laboratory experiment were as follows: 200, 300 and 400 revolutions per minute (rpm); 25 and 30 °C temperature; 1, 1.5 and 2 volume per volume per minute (vvm) aeration; 4.5, 5 and 5.5 pH values. Dissolved oxygen levels were measured in each case. Value settings and yeast growth were evaluated by the proprietary software of the fermentor. In our experiments, samples for protein determination were taken at 0, 24, 48 and 72 hours, the samples were dried at 105 °C in a drying oven, and protein determination was carried out on 1 g of dried sample using the Kjeldahl nitrogen determination method. Measurements were repeated three times according to the methodology described by Csapó and Csapóné Kiss (2003) in their Food chemistry book **[4]**.

5. Results and evaluation

5.1. Optimization of the experimental setup of the fermentation and the determination of yeast protein content

Final fermentation parameters were selected from the fermentation parameters listed in the Materials and methods section under laboratory conditions using several measurement methods. We are not going to go into the details of these measurement processes in the course of the present publication, we will only focus on the protein content determinations. The final values selected were threefold dilution, a temperature of 30 °C, a pH value of 5.5, a speed of 200 rpm and 1.5 vvm aeration, and dissolved oxygen levels were monitored in each case. During the selection of these values, a literature analysis was also conducted. In their publication, Traviña-Muñoz et al. (2013) used speeds of 200-300-400 rpm, with a temperature of 30 °C and 0.5-1-1.5 vvm aeration **[20]**. The highest yield was obtained with the values 200 rpm and 1 vvm. The fermentation values examined by them were nearly identical to the ones used by us, which was a great help during the optimization process.

Following the optimization process, 3 parallel protein determinations were carried out at hours 0, 24, 48 and 72, the results of which are summarized in **Table 1**.

Based on our results it can be stated that we see a potential for the future in the 31.2±0.3 g/100 g yeast protein produced under laboratory conditions over 72 hours for IBD patients requiring a protein rich diet. For a more thorough investigation, in addition to laboratory experiments, large scale production is recommended. Additionally, we believe that it is important to carry out organoleptic tests, to make this alternative protein source, possibly in a flavored form, acceptable to groups or individuals in online forums or patient meetings.

6. Conclusions

During the analysis of the available literature sources, it was found that the incorporation of yeasts in the diet is a current nutritional science task as it can be used effectively in the case of IBD patients. The special products manufactured for them, containing SCPs, may have a beneficial dietary effect during the treatment of individuals suffering from IBD diseases. At the same time, it has also been determined that the characteristics of SCPs do not appear in the literature together with the alternative dietary possibilities of IBD patients or the research results regarding this topic. In order to promote further research, we have tried to outline these in our publication. During the study of literature sources and the carrying out our own experiments, we came to the conclusion that our research should be continued with the practical incorporation of the single cell proteins produced, taking into account Hungarian needs and economic possibilities.

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