

Evaluation of PhD-thesis submitted by **Mr. Jonas Trummer**.

Title:

Evaluation of innovative raw materials suitable for production of high quality malt and beer.

Thesis submitted August 2022 to

University of Agriculture in Krakow
and
Ghent University

The thesis is written in English and contains 180 pages. The main text covers 125 pages, that are divided into 8 separate chapters that comprise introduction, a literature review, research plan, materials and methods, results and discussion, summary, main conclusions, and thoughts on ecological impact and product development. The text is generally easy to read and with very few grammatical and spelling errors. The structure of the text appears logical and is presented in a consistent and clear way.

The abstract is slightly more than one page long, and is given in English, Polish and Belgian versions.

The thesis contains 351 references, mainly only to scientific publications and with the major part published after 2000.

The thesis contains 22 tables and 41 figures, that all are of good graphic quality and that generally present data in a concise and clear style.

It is stated in the thesis, that the PhD-project has resulted in two papers in refereed international scientific journals, where Mr Trummer is first author, a book chapter about grains for malting a brewing, and a home page and database about starchy materials.

Jonas Trummer has given two oral presentations and presented one poster at international conferences. Mr Trummer has furthermore supervised 3 Msc students and one BSc student.

The context and the outline of the phd-project is very briefly introduced in the Introduction chapter (< 2 pages). This is followed by a comprehensive literature review (50 pages). The first part introduces the basic principles of conventional barley malting and brewing processes. Since the aim of the project has been to use new brewing raw materials, there should have been a brief discussion of what defines a beer and what the accepted flexibility is within this product category. A short and very vague definition is stated without a reference on page 22 (according to the stated definition distilled malt-based products like whisky are also beer!).

Next follows an overview of brewing raw materials (both conventional and novel alternative raw materials) with a focus on brewing performance. The raw materials are all presented separately, and a comparison and discussion of their advantages and limitations as brewing raw materials against each other should have been included. Lentils, which is the raw material in focus in the PhD-project is covered in detail (22 pages), where history, physiology, cultivation, structure, composition, functional properties, and processing are comprehensively presented with emphasis on the potential use as a brewing raw material.

This is based on a broad selection of references, however, very few references are published after 2010, and the most recent knowledge related to lentils is therefore missing.

Gluten-free beer is briefly introduced (1 page). Since this is another focus point of the phd-project this should have been expanded – and especially with a discussion of advantages and disadvantages of the different ways of producing gluten-free beer.

The literature review is finished with a summary where the malting and brewing properties of lentils are summed up.

A short separate chapter (< 2 pages) on ecological impact and product development is surprisingly (mal)placed in the thesis as the last part after perspectives and conclusions! The content of this chapter is nevertheless of utmost importance for understanding the current widespread trends to use alternative raw materials in brewing. The environmental aspects should have been an integrated and expanded part of the literature review, both because of its actuality and its importance in relation to the timeliness of the objectives of the project.

Overall, the literature review is solid and based on an academically mature use of scientific knowledge. It gives a well-documented and focussed overview of the existing knowledge in relation to using lentils for malting and brewing.

The objectives and an overview of the project is satisfactorily presented in a clear and precise way in chapter 3. There is no indication of the research being hypothesis-driven, and the scientific plan tends to be more based towards a phenomenological characterisation of the properties of lentils as new raw material for malting and beer brewing.

The Research Method chapter (10 pages) presents all the applied experimental work from lab- to pilot scale. Many analytical methods are presented without references (e.g. “odour and colour determined according to experience of lentil farmers”) and it is not clear if local or internationally well established procedures have been followed.

The results and discussion chapter is divided in four parts reporting the experimental results of 1) different malting regimes for green lentils, 2) lab scale mashing of pure lentil malt, 3) laboratory scale mashing lentil malts as adjuncts, and 4) a pilot scale brewing with lentil malt as adjunct. In each of these parts the products (malt, sweet wort and beer) have been extensively characterised using several brewing relevant analytical methods and with sound scientific analyses of results. The thesis reports a consistent and comprehensive set of data covering from malting of lentils to the final beer, that provide valuable new knowledge on lentils as brewing adjuncts. It is demonstrated that beer with low gluten content can be made with up to 20% lentil malt. Furthermore, it is shown that the malting process of lentils can be more than 50% shorter than for barley, while the extract level is similar or higher than in other alternative brewing adjuncts. In addition, it was demonstrated that the use of lentil malt may improve and shorten the wort filtration process, have positive effects on the levels of zinc and pH of wort, and foam stability of the beer.

The results are all discussed separately when they are presented in the thesis and with relevant references to scientific literature. This results and discussion chapter could have benefitted by having combined summarising discussion of all results and findings, where the main conclusions were discussed in conjunction with each other and against the aims of the project. The following chapter is a rather detailed summary and presentation of perspectives

(5 pages), however no scientific references are cited. This chapter could with moderate expansions have provided the missing overall discussion.

The important conclusions of the project are finally listed in a concise and clear way. Overall, the project has, based on a systematic literature review and a thorough experimental work, proven the versatility of lentils in beer brewing, and has resulted in new knowledge about the specific properties and behaviour of lentils during malting, mashing and brewing. The thesis demonstrates that Mr Trummer is able to apply and produce knowledge in the scientific field of malting and brewing in a scientifically mature manner.

It is therefore concluded that the doctoral dissertation meets the requirements specified in the Act on degrees and academic title as well as on degrees and title in the field of art of March 14, 2003 (Journal of Laws of 2017, item 1789) and the provisions introducing the Act - Law on Higher Education and science, to obtain a doctoral degree in agricultural sciences in the discipline of food and nutrition technology.

In connection with the above, I appeal to the discipline council of food technology and nutrition of the University of Agriculture in Krakow for the acceptance of the doctoral dissertation and admission of Mr. Jonas Trummer (PhD student) to further stages of the doctoral dissertation.

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