PhD EXAMINATION BOARD - PhD THESIS EVALUATION FORM

Name of PhD Candidate: Jonas Trummer

Title of thesis: Evaluation of innovative raw materials suitable for production of high quality malt and beer

1. Does the title cover the content of the manuscript?

The literature overview covers indeed several innovative raw materials for the production of high quality malt and beer, but the actual original research performed is limited to lentil malt. So the title seems more broad than the research.

2. Overall scientific level – originality

Poor. Inadequately addressed, or there are serious inherent weaknesses.

Fair. Broadly addressed, but there are significant weaknesses.

Good. Well addressed, but a number of shortcomings are present.

Very Good. Very well addressed, but a small number of shortcomings are present.

Excellent. Successfully addressed. Any shortcomings are minor.

3. Experimental Part – Methodology - Data Analysis

Poor

Fair

Good

Very Good

Excellent

4. Discussion and Conclusions

Poor

Fair

Good

Very Good

Excellent

5. Written presentation

Poor

Fair

Good

Very Good

Excellent

6. Graphical presentation

Poor

Fair

Good

Very Good

Excellent

Remarks about the text

Abstract

First investigated => unclear => first time that lentil malt is used for beer production, or is this the first part of the PhD?

What do you mean by "suitable for malting"?

Metal ions => Fe is not written as ion? => $fe^{2+/3+}$

Literature

P16 Figure malting process: add time indication for each process

P20 first paragraph: Liquification = liquefaction

P20 last line: Which volatiles are unwanted?

P21 first paragraph:Tangent-ial stream => fix break

P21 last paragraph: why is oxygen necessary?

P22 first paragraph: yeast can be added for the following fermentation => improve sentence

P22 first paragraph: warmth = heat

P22: initial extract = original extract

P22: after the main fermentation ...

P22: last paragraph: Beer is defined as the alcoholic ... => so Non-alcoholic beer is not beer? Definition of beer is not 100% correct (or specify if it is the definition of a specific country). Cereal grains = % of barley/barley malt?

P22 last paragraph: produced is wrongly spelled

P22 last paragraph: usually, all the used cereals and pseudocereals in brewing can be malted. => clarify sentence.

P23: do not leave excessive white space in your manuscript

P24: header of table: Amaranth malt, Barley malt, ...

P24 header table: you refer to Trummer, 2019, this is inaccessible to me. based on ..., ..., ..., and ... . Indicate where enzymes are used in the mashing process. Indicate which mashing process (congress mash?).

P25 first paragraph: no year for Zweytick, first reference? => use only 1 citation in 1 sentence.

P25 end first paragraph: Gamel does not have a year? => use only 1 citation in 1 sentence.

P25: addition of 20% pre-gelatinised amaranth is a possibility => for what?

P25 last paragraph: Zarnkow does not have a year? => use only 1 citation in 1 sentence. => adjust in rest of the manuscript

P26: Wijngaard...

P27: nearly comparable = not comparable?

P27: Poreda => use only 1 reference in 1 sentence. => adjust in rest of the manuscript

P27: avoid overly short sentences: Millets are gluten free.

P27: ended in the best results for all of them => improve language

P27: what is the gelatinization temperature of barley malt?

P27: are in the direction of ... => improve language.

P27: is the wort FAN impacted by pre-cooking for millet? Now it seems like it => make this more clear if it is the case.

P27: kettle feed => cattle?

P28: unmalted oats as an adjunct is more advisable => than?

P28: why do you mention that husk is an advantage for oats but not for rice?

P28: Zarnkow et al has no year?

P29: rice in normal mashing procedure gives no saccharification => due to low enzymatic content of rice malt?

P30: raw spelt = unmalted spelt? => be consistent

P31: the positive effects on foam stability overlap => what is meant by overlapping? Make this more clear.

P32: Kamut is a brand name => use Khorasan.

P32: malting and brewing of grains... => improve language, "brewing of grains" is not good English

P33 first paragraph: this research aims to investigate ... => is not part of literature overview. Belongs under "aims"

P34: grown in batches => not clear what you mean

P35: choosing support fruit => support crop?

P35: Bare barley? => what is this? (naked barley?)

P35: 2.5 to 4 => use same sign number

P36: incorrect citaton: muehlbauer

P36: 1-2.5% => use same signf numbers

P36: Conception Vidal-valverde => reference does not exist?

P37: 20 to 45.5% => same signf numbers

P37: avoid excessive white space

P37: W.S. Ratnayake => citation not in line with other citations?

P38: resistant starch => would this resist the brewing process?

P39: can barley malt be added to the table?

P41: the exceptions in lentils are => reformulate

P42: during the malting process => specify further if this is for lentil malt or barley malt (consumption of fat during malting).

P42: as some fatty acids => reformulate sentence

P44: A lower concenration of fat-soluble vitamins ... => lower than?

P44: due to low oil content of lentils => not in line with P42; oil content seemed to be higher in lentils than in barley?

P44: Morad et al => ...

P45: Nakagawa ; xu et al => fix citation

P46: additionally, some phenols are able to chelate metals ... => now it seems positive that these phenols can chelate metal ions, is this what you meant? Later on it seems undesirable => clarify

P47: divided => use other word

P47: Morad => ...

P47: the activity of the alpha amylase is 2.4 times higher => than?

P47: Petrova => ...

P48: some of the functions are in list-form other functions are in text-form => make uniform

P48: chimotrypsin => correct spelling

P48: do not repeat citations: fernandez-Orozco (xxx)

P49: do not repeat citations (cai et al, zhao et al, ...)

P50: avoid excessive white space

P50: "storage insects" => insects

P51: practise => practice

P52: check reference Barilla

P52: boiling always results in reduction of fats and carbohydrates, but more proteins => reformulate sentence. Two unrelated pieces of information should not be coupled together

P52: recovery of thiamine content => reformulate

P52: alpha galactosidases => be consistent in writing

P52: Urbano => ...

P53: Verni => ...

P55: legue => legume?

P56: significant supply of polyphenols => use significant only in statistical context

Objectives

P57 => 2: reformulate, it is not clear what is meant => wort production with 100% lentil malt?

P57 => 3 and 4 => same remark => make unambiguous

P58 => II , III and IV => same remark=> make unambiguous

P60: table 13 and 14: put table in the text where it is first referred

P60: humidity controlled cabinet => what was the humidity?

It is not clear why you want to investigate novel raw materials for malting and brewing.

Methods

P63: which followed EBC and MEBAK ... => reformulate => according to ...

P63: the amount of barley malts was ... => both pilsner and chocolate malt or only pilsner malt? => specify

P63: the young beer => a bit unclear what you mean

P65: odour => briefly describe the procedure

P65 : moisture content => idem => briefly describe the procedure + apparatus => was this done in triplicate => maybe add an extra section where you describe the statistics: how many replicates, mean and stdev calculated? ...

P65: Planas => don't repeat citations

P65: enzymatic => keep sentences as part of paragraphs. No single sentences

P66: can you specify milling size for congress mash and pasting properties

P66: was turbidity measured at 90° or 25°?

P67: better view of yeast behaviour than?

P67: briefly mention how extract was measured: Anton Paar? Same measurement as fermentation performance? => make one section

P68: Used plastic cups => Plastic cups

P69: where does the equation come from? Why different weights for different attributes?

P70: fig 12: use same sign numbers in figure

P70: analysis of gluten concentrations is repeat of earlier description

P70: average of at leasts three independent experiments => every beer was brewed three times? Every malt was produced tree times? Or was analyzed three times?

Results and discussion

P72: Table 12 => are not your results => should be in materials and methods

P72: organise sentences in paragaphs, avoid single sentences

P73: table 13 => are not your results => should be in materials and methods

P73: Table 14 => idem

P74: why would more proteins always result in low extract?

P74: can you elaborate why this specific green lentils were chosen for this project?

P75: making a table for only 3 values might be overkill. Implement in text.

P75: Germinative energy => you describe the procedure => why is this not in materials and methods?

P75: Bishaw => ...

P75: why is the magnetic field important to mention can you elaborate on that, does this impact the germination?

P75: water sensitivity => explanation should be in materials and methods

P75: enzymatic acvitity of green lentils => no information is given in this section => or you leave it out or you provide the appropriate information in this section.

P77: are we seeing the roots or the shoots?

P78: How are you sure that the germination process does not stop below for example 52%? Is this by comparison with barley malt.

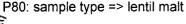P78: possibility of higher malt production => reformulate

P78: gasinski => ...

P78: explanation about +E belongs in header of table.

P79: why is there no moisture content in RL+E? If values are means with standard deviation, why do I not see standard deviation for pasting properties?

P79: was there no difference between the different malts? NO color difference, no odour difference? If so => mention this

P80: 1.6 and 3.3%? => see table

P80: sample type => lentil malt

P80: 3.00 to 3.5% => same sign numbers?

P81: increase in moisture content at 80° => reformulate => less decrease in moisture content

P83: only slight viscosity drop from 32 to 21 was observed... this suggest that the exogenous enzymes used are the same enzymes active in the barley malt mas without addition => can you elaborate how you came to that conclusion?

P 83: liquefaction?

P83: gasinski => ...

P84: how do you know sufficient enzymes were added to allow optimal extraction?

P85: use same signf numbers for same type of analysis

P85: can you add the efficiency when rice or maize is added to the brewing process?

P85: can you elaborate on the measurement of B-glucan in materials and methods? Now it only says that it is calculated.

P86: enzymeS present

P86: Morad => ...

P86: why did you not measure the enzyme activity of the green lentil malt?

P86: hydrolisation => hydrolysis

P86: Tarrag => ...

P87: what is a usual Beta-glucan content of barley malt and barley?

P86: beta-glucan content accordingly was .. => remove accordingly

P87: beta glucan can lead to filtration problems => repeated in text => remove one

P87: higher b-glucanase activity and therefore higher beta-glucan content => why is this so?

P87: gasinski => ...

P87: explanation about +E is for in header table

P88: how was filtration time determined => add brief explanation to materials and methods, same as saccharification time.

P89: glucanases = beta-glucanases? Glucans = beta-glucans

P93: gasinski => ...

P94: abbreviation LM not explained in label figure 22

P94: indicate if you are talking about beta glucan or other glucans, amylose is also a glucan

P95: do not refer to a figure that is not immediatelyl following the reference. (figure 29) Or it is important and you add the figure immediately after the reference or it is not important and you remove the reference, or you refer to a later section.

P95: why is reduced mash filtration time interesting ecologically?

P96: a small decrease in FAN was stated => was found

P96: agu and palmer => ...

P96: when are solble proteins hydrolysed: malting, mashing, or fermentation?

P96: which correlates with the results of the Congress wort turbidity => specify exactly which congress wort turbidity. Is it positive or negative correlation?

P98: LM has not been explained in label figure 24

P98: no double citations in one sentence (gasinski)

P99: if results are descibed in the text without interpretation, as well as in a figure, one of the two is considered redundant.

P99: pH drop leads to decrease of the colour => can you provide reference?

P101: rootlet growth => is the rootlet the only plant part that needs starch?

P102: but statistically significant difference was stated => was found

P103: will have the final impact on colloidal => improve language

P103: use same signif numbers in y axis figure 28

P104: what is an expected turbidity for congress mash of barley malt?

P105; remove point before citation of lestienne

P105: Wang and daun => ... ; Poreda => ...

P106: after the main fermentation

P107: is iron considered a heavy metal?

P107: which need to be stated => what is meant here?
P108: abbreviation LM not explained
P109: stated an ideal breakdown => reformulate
P109: divided into several ...??
P109: no excessive white space
P110: duplicate information from table 21?
P109: mashing at 68°C for pilot scale => not same as in materials and methods??
P111: FAN of wort and beer is now three times shown: in table, in text and in figure => no duplicate information
P112: use "significant" only in statistical context
P112: pH: three times same information ...
P113: adjunct.. => correct
P113: pathogen = pathogenic; check that statement, is incorrect in my opinion.
P115: figure 33: use straight lines between points, curved lines insinuate that this is a model. You don't have any information about how the values change between the measured points.
P118: figure 35: same significant numbers on y axis.
P118: proof and verify the measured apparent extrac => why proof AND verify? What is the difference?
P120: same significant numbers on y axis
P120: you use IBU, but I the EBC method is expressed as EBU?
P122: Owusu Apenten => reference not in bibliography?
P124: new brewing techniques with more shear .... => what is meant with this sentence?
P127: no excessive white space
P126: explain LM and DLG in header
P130: consist of gluten => reformulate
P134: low-in gluten => low in gluten

Specific comments

In the literature overview, only little attention is given to soaking and sprouting/germinating of lentils, even though this is a common way to prepare legumes before cooking. I suggest elaborating on the effects of this process, as it is closely related to the malting procedure. For example, make a different subtitle under processing.

Legumes typically contain lectins, but these compounds are not mentioned in this manuscript. I suggest elaborating on lentil lectins, for example, make a different subtitle under chemical composition.

Materials and methods are not always sufficient to understand the analyses, as this often requires looking at the EBC protocols. I suggest to make this more clear by incorporating the main principles of each method in the section materials and methods. Materials and methods are not always in agreement with what is written in results and discussion (see above).

In the results and discussion section, much of the information is two or even three times repeated, in text, tables and/or figures. I suggest removing redundant information.

Citations and references contain mistakes and duplicates. References at the end of the manuscript are not carefully checked (capital letters in titles incosistent, journals sometimes abbreviated and sometimes not, information missing for some references (eg page numbers), not always similar layout (interline space differs), names of organisms not in italic). I suggest carefully checking the citations and references.

General conclusion

This doctoral thesis answered the question if it is possible to produce beer with lentil malt, a raw material that has not yet been fully explored in the brewing industry. This applied research contributes to the ongoing search for novel and innovative beers, and provides a better understanding of the use of barley malt for the production of beer.

The doctoral candidate has reviewed the existing literature whereby the relevant field has been covered. However, some aspects were missing or should be covered in more detail. Several objectives were outlined and the original research process is described in materials and methods. Many methods were used without mentioning the most important principles of the method. Some inconsistencies were found between the materials and methods, and the results and discussion section.

The amount of experimental work performed for this doctoral dissertation is limited but sufficient to answer the basic scientific questions. The basic analyses for the evaluation of the experimental work were performed with sufficient precision to come to valuable conclusions. However, more in-depth experiments and analyses were lacking, which resulted in limited depth and detail of the presented research.

The manuscript is quite clearly written and easy to read, but there is improvement possible with regards to scientific writing. Information is often presented in two or even three ways, which accounts for redundant text. Citations and references are not carefully implemented, as a many errors were found. Nevertheless, the arguments are presented in a logical and transparent way, and are adequately structured.

Overall, 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.

The undersigned considers that the work needs **minor** revisions. During the first examination board meeting, the candidate will be submitted to a preliminary defence in which the candidate will be questioned with respect to the technical content of the PhD thesis. During that meeting, it will be decided whether or not the current form of the PhD thesis can be accepted so that the Scientific Board can make the decision regarding the public defence. The undersigned guarantees to make every effort to participate in this preliminary defence.

Name committee member: **Dr. ir. David Laureys**
Date: **17/01/2023**   Signature:

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Remarks to the chair of the exam committee with respect to the PhD thesis <u>(this information will only be sent to the chair!)</u>

1. **Motivation of evaluation**

2. **Weak points, lack of argumentation, essential scientific arguments supporting the discussion**

3. **In principle, a PhD dissertation is not immediately rejected. Yet, if there are fundamental reasons for rejection, please provide them here.**

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