

THE ROLES OF XANTHAN GUM, POTATO
STARCH, AND SORBITOL IN THE
FORMULATION OF GLUTEN FREE BREAD

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Roti adalah makanan asas dalam kehidupan seharian dan ianya sukar untuk dimakan oleh pesakit *celiac*. Penyakit *celiac* ialah sejenis penyakit jangka panjang yang melibatkan jangkitan pada usus kecil yang disebabkan oleh kehadiran gluten. Gluten ialah komposit yang terdapat di dalam penyimpanan protein terdiri daripada jujuk prolamins dan glutenins, di mana ianya merupakan komponen utama dalam produk bakeri. Tanpa kehadiran gluten di dalam roti, ianya akan mengganggu struktur doh. Ujikaji pengoptimuman formulasi roti telah dikaji dengan menggunakan kaedah rekabentuk Box-Behnken. Penggunaan tiga pembolehubah serta tiga tindakbalas menggunakan kaedah tindakbalas permukaan, digunakan untuk mengoptimumkan formulasi. Berdasarkan keputusan, sebanyak 1.04g gam xanthan, 40g kanji kentang dan 5.15g sorbitol diperlukan untuk formulasi yang dioptimumkan, di mana ianya menggunakan tepung beras dan tepung ubi kayu sebagai bahan utama. Pada keadaan optimum ini, kelembutan roti dapat dikurangkan sebanyak 2.63N manakala berat dan isipadu roti ditingkatkan pada 401.65g dan 891.78cm³. Pihak responden telah memberikan skor 8.30 dan panel penilai telah memberi skor 8.44 mewakili skala sangat suka bagi penerimaan secara keseluruhan untuk formulasi optimum. Sembilan panel terlatih telah memberikan markah 7.78 untuk atribut rasa, 1.00 untuk atribut kelembutan dan 8.44 untuk atribut aroma. Nilai bacaan warna pada kerak roti, ialah L=70.35, a=5.80, and b=25.59, memberikan warna kerak yang lebih pucat. Warna bagi roti ialah L=80.51, a=-1.65 and b=10.84, menunjukkan roti mempunyai warna putih yang setanding dengan roti putih di pasaran. Nilai nutrisi roti bagi formulasi optimum mengandungi 81.14% karbohidrat, 8.85% protein kasar, 7.86% lemak kasar, 0.69% serat and 2.15% abu. Jangka hayat roti ialah 5 hari selepas dibakar dengan melihat pada pertumbuhan kulat pada hari pertama. Kadar pengerasan roti meningkat sebanyak 5.6N manakala kandungan kelembapan menurun sebanyak 1.2% selepas 72 jam dibakar. Melalui analisis mikrob, dengan menggunakan kaedah jumlah kiraan plat, sepanjang 24 jam eraman ialah 1.5x10¹ kemudian bertambah menjadi 5.3x10⁴ selepas 72 jam. Kiraan kulat pula didapati sebanyak 1.3x10¹ sepanjang 24 jam eraman dan bertambah menjadi 6.5x10⁴ selepas 72 jam. Kesimpulannya, kaedah tindakbalas permukaan telah berjaya mengoptimumkan formulasi roti tanpa gluten yang dihasilkan. Penambahan gam xanthan, kanji kentang dan sorbitol di dalam jumlah yang tepat ke dalam formulasi didapati telah meningkatkan kualiti roti dengan menjadikan roti lebih lembut, dan meningkatkan isipadu dan berat roti. Selain itu, roti yang dihasilkan juga mempunyai penerimaan yang baik daripada segi sensori, di samping bebas daripada kandungan gula, bahan kimia tambahan dan pengawet.

ABSTRACT

Breads is a staple food for everyday life and the most difficult product to replace for celiac. Celiac disease is a lifelong inflammatory disease in small intestine caused by exposure to gluten. Gluten is a composite of storage proteins term prolamins and glutelins, where it is major component in bakery product. Cutting off the gluten will disrupt the technological structure of the dough. The effects of various experimental parameters in optimizing the bread formulation were studied using a Box-Behnken design methodology. A three level with three responses, which combined with response surface modelling, it was used to optimise the formulation. The results showed, 1.04g of xanthan gum, 40g potato starch and 5.15g sorbitol required for optimized formulation with rice and tapioca flour as a main ingredient. At this optimum condition, the firmness of bread crumb was reduced by 2.63N, but the weight and volume were maximized by 401.65g and 891.78cm³. Respondents give a score of 8.30 while the trained panel give a score of 8.44, representing the attribute of like very much in the optimum formulation. Nine trained panels give score of 7.78 for taste, 1.00 for crumb firmness and 8.44 for aroma. The colour of bread crust was L=70.35, a=5.80, and b=25.59, which has pale crust colour. The colour of bread crumb was L=80.51, a=-1.65 and b=10.84, show it has white crumb color approaching the color of white bread in the market. The nutritional contents showed the optimized bread have 81.14% carbohydrate, 8.85% crude protein, 7.86% crude fat, 0.69% of fibre and 2.15% of ash content. The shelf life of bread is 5 days, by observing moulds growth on the first day. The staling rate increased 5.6N and the moisture content decreased 1.2% after 72 hours of baking. Consequently, the staling rate can be slowed down by increasing the moisture content in the bread crumb. The microbial analysis in total plate count during 24 hours incubated is 1.5×10^1 then grown up to 5.3×10^4 after 72 hours. The moulds count during 24 hours was 1.3×10^1 and grown up to 6.5×10^4 after 72 hours. As a conclusion, the response surface methodology had aided in optimizing a gluten free bread formulation. The addition of xanthan gum, potato starch and sorbitol with the exact amount has improved the quality of bread produced by reducing crumb firmness, increase volume expansion and weight of loaf. Furthermore, the bread has a good sensory acceptance's, and sugar free without chemical additive or preservative.

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LIST OF SYMBOLS

%	Percentage
∞	Glycosidic bonds
μm	Micro meter
°C	Degree Celsius
°F	Degree Fahrenheit
L	Measure of lightness or darkness
a	Measure of greenness or redness
b	Measure of yellowness

LIST OF ABBREVIATIONS

AACC	American Association for Clinical Chemistry
AOAC	Official Method of Analysis
ANOVA	One Way Analysis of Variance
BF	Buckwheat flour
CIELAB	International Commission on Illumination Lab
cfu	Colony forming unit
DF	Degree of Freedom
FDA	Food and Drug Administration
g	Gram
h	Hour
GFB	Gluten Free Bread
HCl	Hydrochloric Acid
HMF	Hydroxymethylfurfural
HSD	Honest Significant Difference
H ₂ SO ₄	Sulphuric Acid
H ₂ O	Water
LDPE	Low Density Polyethylene
LSD	Least Significant Difference
MAP	Modified Atmosphere Packaging
N	Nitrogen
N ₂	Nitrogen gas
NA	Nutrient agar
NaOH	Sodium Hydroxide
PDA	Potato Dextrose Agar
RF	Rice flour
RSM	Response Surface Methodology
RS	Resistant Starch
TF	Tapioca flour
SPSS	Statistical Package for the Social Sciences
Stdev	Standard deviation
UK	United Kingdom

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