PHYSICOCHEMICAL PROPERTIES AND ACCEPTABILITY STUDIES OF CEREAL BAR PRODUCED FROM PUFFED GLUTINOUS RICE AND SELECTED SUNNAH FOODS USING DIFFERENT PACKAGING MATERIALS

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DEDICATION

This thesis is dedicated to the Glory of Allah and His beloved Prophet Mohammed (SAW), and to the memory of my beloved father who has passed away, Mr. Agbaje Badru Alamu. May Almighty Allah grant him Janatul-Firdaus. Amin.

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ABSTRAK

Kajian ini telah dijalankan untuk meneroka kesesuaian formulasi bar bijirin dengan buah-buahan Sunnah yang dapat menyumbang kepada kesihatan manusia. Bar bijirin telah dinilai untuk analisis anggaran nutrien, penilaian berasaskan deria, dan kandungan tenaga. Ujian penerimaan pengguna kepada bar bijirin telah dijalankan menggunakan skala 9-titik hedonik. Jangka hayat bar telah dikaji berdasarkan material pembungkusan, aktiviti air, dan kandungan lembapan selepas 120 hari penyimpanan. Bahan-bahan pembungkusan yang telah digunakan adalah nilon (poliamida), poliester *metallised* (MP), polietilena terephthalate (PET), dan kerajang aluminium (AF). Kalsium merupakan mineral utama (186.54-482.9 mg/kg) yang diperolehi. Sampel-sampel bar bijiran yang diuji juga turut mengandungi natrium, 70.54-235.86mg/kg; besi, 33.64-41.52mg/kg; zink, 29.76-50.95mg/kg; mangan, 12.52-17.05mg/kg; tembaga, 11.86 - 13.73 mg/kg; dan magnesium, 88.00-160.14mg/kg.Dalam analisis berasaskan deria, kesemua formulasi bijirin bar mendapat skor penerimaan pengguna yang tinggi.Walaubagaimanapun, sampel C mempunyai penerimaan keseluruhan yang tertinggi (6.58). Tidak terdapat perbezaan dalam kandungan protein dalam bar bijirin yang digubal. Kandungan abu dalam sampel berbeza dengan ketara ($P < 0.05$), nilainya adalah antara 0.97 dan 1.88. Perbezaan kandungan lemak adalah ketara dengan sampel B mempunyai kandungan lemak (10.72%) yang tertinggi. Kandungan karbohidrat dipengaruhi oleh kandungan serat; sampel dengan kandungan gentian kasar yang rendah mempunyai kandungan karbohidrat yang lebih tinggi yang juga mencerminkan kandungan tenaga dalam sampel bar bijirin. Aktiviti air yang rendah diperhatikan dalam sampel dengan kandungan buah-buahan yang lebih rendah. Kajian jangka hayat mendedahkan bahawa aktiviti air (a_w) bar-bar adalah jauh di bawah nilai-nilai yang boleh menggalakkan percambahan mikrob yang akan membawa kepada kerosakan bar-bar. Poliester *metallised* (MP) dan kerajang aluminium (AF) menunjukkan sifat-sifat untukpenyimpanan yang lebih baik berbanding PET dan nilon.

ABSTRACT

This research was undertaken to explore the feasibility of formulating cereal bars with *Sunnah* fruits that could contribute to the human health. The cereal bars were evaluated; its nutrients and energy as well as consumer acceptance. The consumer acceptability of the cereal bars was carried out using 9- point hedonic scale. The shelf life of the bars was studied with respect to packaging materials, water activity and moisture content after 120 days of storage. The four packaging materials were nylon (polyamide), metallised polyester (MP), polyethylene terephthalate (PET) and aluminium foil (AF). Results found out that calcium was the major mineral (186.54 – 482.9 mg/kg). The samples contained sodium, 70.54-235.86mg/kg; iron, 33.64-41.52mg/kg; zinc, 29.76-50.95mg/kg; manganese, 12.52-17.05mg/kg; copper, 11.86-13.73mg/kg; magnesium, 88.00-160.14mg/kg. Results also revealed there were no differences in protein contents of the cereal bars formulated, (3.38-4.04%). Ash contents of the samples were significantly different ($P< 0.05$), the values ranged between 0.97 and 1.88%. The fat contents were significantly different with formulation **B** having the highest fat content (10.72%). Carbohydrate contents were affected by fibre contents; samples with lower crude fibres had higher carbohydrate contents, as a result of lower fruit contents; this also reflected in the energy contents of the cereal bar samples. The lowest water activity was observed in the samples with lower fruit contents. In sensory analysis, all the cereal bar formulations had high sensory acceptance. However, formulation **C** had the highest overall acceptance (6.58).The shelf life study revealed that water activity (a_w) of the bars were well below the values that could encourage microbial proliferation that would lead to spoilage of the bars. Metallised polyester (MP) and aluminium foil (AF) showed better properties of storage as compared to PET and nylon. In conclusion, incorporation of puffed glutinous rice with different composition *Sunnah* foods and binding agents; honey and glucose syrup can be used to formulate cereal bars with appreciable proximate and energy contents with good shelf life.

Keywords: cereal bar; packaging; mineral elements; shelf life; sensory evaluation; *Halal/Sunnah* foods.

ملخص

أجري هذا البحث لاستكشاف فوائد سيريال بار (أشرطة الحبوب) مع الفواكه المذكورة في السنة النبوية الشريفة ومدى إسهامها في صحة الإنسان، تم تقييم سيريال بار (أشرطة الحبوب) للتحليل المباشر، والتحليل الحسي، ومحتويات الطاقة، ولمعرفة مدى قبول المستهلكين لسيريال بار قد استخدمت 9 نقاط للتقييم على حسب ذوقهم، كما تمت دراسة مدّة صلاحية سريال بار التي تتراوح 120 يوما من التخزين، وذلك على حسب التعبئة والتغليف وصلاحية الماء ومحتويات الرطوبة. وكانت مواد التعبئة والتغليف أربعة وهي النايلون (البولي أميد)، البوليستر الممعدنة و البولي ايثلين ورقائق الألومنيوم. كانت الكالسيوم المعدن الرئيسي بمقدار يتراوح ما بين – 186.54 482.9 mg/kg، واحتوت العينات الصوديوم بمقدار 70.54-235.86mg/kg حديدا، و33.64-41.52mg/kg زنكا، و29.76-50.95mg/kg منغنيز، و12.52-17.05 mg/kg النحاس، و 13.73mg/kg -11.86 مغنيسيوم، 14 mg/kg. 160 -88.00.

وفي التحليل الحسي، كانت نسبة قبول المستهلكين في تقييم سريال بار عالية، ومع ذلك كانت القبول العام لعينة C أعلى بمقدار(6.58)، ولم تكن هناك اختلافات في محتويات البروتين في سريال بار المكونة، أما محتويات العينات فمختلفة إلى حد كبير بمقدار ($P\leq 0.05$)، وتتراوح مقدار الفرق ما بين 0.97 و 1.88، وكانت محتويات الدهون مختلفة إلى حد كبير بمقارنة عينة B التي تحمل أعلى نسبة الدهون (10.72%) . تأثرت محتويات الكربوهيدرات بمحتويات فيبار(الألياف)، والعينات مع أقل الألياف الخام تملك أعلى محتويات الكربوهيدرات التي تتكون أيضا في محتويات عينات الطاقة الكامنة في سريال بار. وقد لوحظ في العينات أن أدنى نشاط صلاحية المياه مع انخفاض محتويات الفاكهة. وكشفت دراسة المدة الصلاحية أن صلاحية فصيل الماء في الحبة كان أقل بكثير من المقادير التي يمكن أن تشجع على انتشار الجراثيم التي من شأنها أن تؤدي إلى تلف الحبوب، كما كشفت الدراسة أن البوليستر الممعدن ورقائق الألومنيوم أظهرت مميزات أفضل في التخزين بالمقارنة إلى البولي ايثلين والنايلون.

كلمات البحث: شريط الحبوب، التعبئة والتغليف، العناصر المعدنية، مدة الصلاحية، التقييم الحسي، الحلال / الأطعمة المسنونة.

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ABBREVIATION

AACC	Association of American Cereal Chemists
AF	Aluminium Foil
ANOVA	Analysis of Variance
AOAC	Association of Official Analytical Chemists
a_w	Water activity
BC	Black cumin
CFAB	California Fig Advisory Board
CCP	Critical Control Point
CHD	Coronary Heart Disease
CVD	Cardiovascular Disease
DF	Dietary Fibre
DRI	Dietary Recommended Intake
FAO	Food and Agriculture Organisation
FOS	Fructooligosaccharide
GS	Glucose Syrup
HSV	Herpes Simplex virus
IA	Index of Acceptability
ID	Iron Deficiency
IDA	Iron Deficiency Anaemia
IFST	Institute of Food Science and Technology
IOM	Institute of Medicine
IQ	Intelligence Quotient
MET	Metallised Polyester
PET	Polyethylene Terephthalate
PGR	Puffed Glutinous rice

ppm	Part per million
QbD	Quality by Design
RH	Relative Humidity
RTE	Ready-to-Eat
RTE-BC	Ready-to-Eat Breakfast Cereal
UV	Ultra violet