

# **STUDIES ON CARBOHYDRATE INTOLERANCE IN SELECTED FOOD**

By

**HANAA GEORGE ISHAK ABDELMESEEH**

B.Sc., Agric. (Food Technology), Fac. Agric., Ain Shams Univ., 2000

**A Thesis Submitted in Partial Fulfillment  
Of  
The Requirements for the Degree of**

**MASTER OF SCIENCE  
in  
Agricultural Sciences  
(Food Science and Technology)**

**Department of Food Science  
Faculty of Agriculture  
Ain Shams University**

**2018**

**Approval Sheet**

**STUDIES ON CARBOHYDRATE INTOLERANCE  
IN SELECTED FOOD**

By

**HANAA GEORGE ISHAK ABDELMESEEH**

B.Sc., Agric. (Food Technology), Fac. Agric., Ain Shams Univ., 2000

**This thesis for M.Sc. degree has been approved by:**

**Dr. Shahinaz Ahmed Helmy** .....  
Prof. of Food Science and Technology, Faculty of Agriculture, Cairo  
University

**Dr. Mohamed Farag Khallaf** .....  
Prof. of Food Science and Technology, Faculty of Agriculture, Ain  
Shams University

**Dr. Mohamed Abdalla El-Hofi** .....  
Prof. of Dairy Science and Technology, Faculty of Agriculture, Ain  
Shams University

**Dr. Ihab Salah Abd El-Hamid Ashoush** .....  
Prof. of Food Science and Technology, Faculty of Agriculture, Ain  
Shams University

**Date of Examination:**    /    / 2018

# **STUDIES ON CARBOHYDRATE INTOLERANCE IN SELECTED FOOD**

By

**HANAA GEORGE ISHAK ABDELMESEEH**

B.Sc., Agric. (Food Technology), Fac. Agric., Ain Shams Univ., 2000

**Under the supervision of:**

**Dr. Ihab Salah Abd El-Hamid Ashoush**

Prof. of Food Science and Technology, Department of Food Science,  
Faculty of Agriculture, Ain Shams University (Principal Supervisor)

**Dr. Mohamed Abdalla El-Hofi**

Prof. of Dairy Science and Technology, Department of Food Science,  
Faculty of Agriculture, Ain Shams University

**Dr. Sameh Samir Raafat Naguib**

Associate Prof. of Cardiology, Department of Cardiology, Faculty of  
Medicine, Ain Shams University

## **ABSTRACT**

**Hanaa George Ishak Abdelmeseeh: "Studies on Carbohydrate Intolerance in Selected Food". Unpublished M.Sc. Thesis, Department of Food Science, Faculty of Agriculture, Ain Shams University, 2018.**

Carbohydrate intolerance begins as a hidden problem; it can progress to a functional disorder producing symptoms like fatigue that negatively affects quality of life, and can gradually result in serious illness such as diabetes or heart disease. The aim of this work was the development and characterization of a functional beverage from wheatgrass extract (WGE), pomegranate juice (PJ), and lemon juice (LJ), also symbiotic dairy drink was developed. The final products were pasteurized and evaluated by the content of Total phenolic (TP), flavonoids (TF) content as well as free radical scavenging activity. Meanwhile, physicochemical properties and the organoleptic attributes were evaluated. Also, the protective effect of functional blending juice against carbohydrate intolerance in patients was investigated by hydrogen breath test. The results revealed that the WGE are low acidic in nature. While, the LJ showed high acidity which raised the total acidity in the functional blending juice. PJ had higher content of total phenolic (17.45 mg/ml) followed by (13.25 mg/ml) for functional blending juice. While, significant increase in the TF (22.15 mg /ml) in the Wheatgrass juice followed by functional blending juice (5.70 mg/ml). Whereas, the results showed that functional blending juice recorded the highest antioxidant activity, which revealed great free radical scavenging activity (98.16%). Depending on sensory evaluation, the proportions of blending ratio WGE 20: PJ 70: LJ 10 was most preferred for consumption by the panelists compared to other blending ratios. After one month for patients group treated by functional blending juice, showed a significant decrease in the concentration of hydrogen level in the exhalation air to reach a significant level of the control patients group, indicating the ability of the active compounds in functional blended juice to relieve the problems of

carbohydrate intolerance. Accordingly, healthy promoting drinks can be produced by adding mixture of pomegranate juice, lemon juice and wheatgrass juice. The obtained fermented milk drinks which fortified with 2% wheatgrass extract have a good sour taste, a unique flavor and a very pleasant smell. This product targets all categories of consumers and represents an ideal morning drink for those who are concerned about a carbohydrate disorder and healthy lifestyle.

**Keywords:** Wheatgrass, Pomegranate, Lemon, Fermented milk, Antioxidant activity, Carbohydrate intolerance, Hydrogen breath test.

## ACKNOWLEDGMENT

First and before all, full praise and gratitude is to ALLAH, who granted me the ability to perform this thesis and helped me to pass safely through all the difficulties.

My sincere appreciation and deepest gratitude to **Prof. Dr. Ihab Salah Abd El-Hamid Ashoush**, Prof. of Food Science, Dept. of Food Sci., Faculty of Agriculture, Ain Shams University, for his direct supervision, with him I learned a lot, at both professional and personal level. His wide knowledge and his logical way of thinking have been of great value for me. His understanding and encouraging have provided a good basis for the present work. I have no great words to express how much I am grateful to him! Thank you so much.

Deepest thanks and sincere appreciation to **Prof. Dr. Mohamed Abdalla El-Hofi**, Prof. of Dairy Science, Dept. of Food Science, Faculty of Agriculture, Ain Shams University, for his supervision, precious advice given throughout the whole study. He was an important support throughout this work.

I also thank **Dr. Sameh Samir Raafat Naguib** Associate Professor of Cardiology Dept., Fac. Medicine, Ain Shams Univ. for suggesting the subject of this work, kind supervision, long lasting beneficial instructions, continuous guidance and continuous encouragement during the course of this work.

Never forget to thank **Prof. Dr. Mamdouh Mohamed Fawzy** Professor of Horticultural, Dept. of Horticulture, Faculty of Agriculture, Ain Shams University, for his assistance in providing and cultivation wheat sprout (wheatgrass) for this study.

Many thanks are extended to all members of Food Science and Technology Department, Faculty of Agriculture, Ain Shams University for their co-operation during this work. Finally, my deepest gratitude is offered to my mother Silvana, husband Osama and my brothers Hany and Happy.

# CONTENTS

	<b>Page</b>
<b>LIST OF TABLES .....</b>	<b>IV</b>
<b>LIST OF FIGURES .....</b>	<b>V</b>
<b>LIST OF ABBREVIATIONS .....</b>	<b>VII</b>
<b>INTRODUCTION.....</b>	<b>1</b>
<b>REVIEW OF LITERATURE.....</b>	<b>4</b>
2.1. Carbohydrate intolerance .....	4
2.2. Functional beverages .....	7
2.2.1. Fermented dairy drinks .....	7
2.2.2. Non dairy beverage .....	10
2.2.3. Wheat sprouts (Wheatgrass) .....	11
2.2.4. Pomegranate .....	14
2.2.5. Lemon .....	17
<b>MATERIALS AND METHODS.....</b>	<b>19</b>
<b>3.1. MATERIALS .....</b>	<b>19</b>
3.1.1. Raw materials.....	19
3.1.2. Chemicals.....	19
3.1.3. Culture media for bacteriological studies .....	19
<b>3.2. METHODS .....</b>	<b>20</b>
3.2.1. Preparation of fresh pomegranate and lemon juices .....	20
3.2.2. Preparation of aqueous extracts of Wheatgrass juice.....	22
3.2.3. Preparation of functional blended juice .....	23
3.2.4. Preparation of symbiotic dairy drink .....	25
3.2.5. Determination of total phenolics content in extracts and drinks .....	26
3.2.6. Determination of total flavonoids in extracts and drinks .....	27
3.2.7. Determination of antioxidant activity .....	27
3.2.8. Sensory evaluation of symbiotic dairy drink and functional blending juice .....	27
3.2.9. Physicochemical analyses of symbiotic dairy drink and functional blending juice.....	28

## II

	Page
3.3. Microbiological analysis .....	28
3.3.1. Pour plate technique .....	28
3.3.2. Modified wallerstein laboratory nutrient agar .....	28
3.3.3. Modified MRS solid agar for the detection of anaerobic spoiling bacteria .....	29
3.3.4. Salmonella and Shigella agar .....	29
3.3.5. Kf streptococcus agar .....	29
3.3.6. Detection and enumeration of anaerobic sulphite-reducing bacteria (differential clostridia agar) .....	29
3.4. Subjects .....	30
3.4.1. Experimental Protocol.....	30
3.4.2. Demographic and other baseline characteristics of the studied subjects.....	30
3.4.3. Anthropometric measures of the studied subjects.....	31
3.4.3.1. Body weight and length .....	31
3.4.3.2. Body mass index (BMI) .....	31
3.4.4. Hydrogen breath test .....	31
3.4.4.1. Patient preparation .....	31
3.4.4.2. Procedure of the hydrogen breath test .....	32
3.4.5. Biochemical analysis.....	32
3.4.5.1. Samples .....	32
3.4.5.2. Lipid profile analysis .....	33
3.4.5.3. Selected blood picture parameters .....	34
3.4.5.4. Postprandial blood sugar .....	34
3.4.5.5. Liver function enzymes.....	34
3.4.5.6. Kidney function .....	35
3.4.6. Follow up .....	36
3.5. Statistical analysis .....	36
<b>RESULTS AND DISCUSSION .....</b>	<b>37</b>



### III

	Page
4.1. Sensory evaluation of the different functional juices blend and symbiotic dairy drink .....	37
4.2. Physicochemical characteristics of different functional juices blend and symbiotic dairy drink.....	41
4.3. Antioxidant status of different functional juice blend and symbiotic dairy drink .....	44
4.4. Bacteriological quality of different functional juice blend .....	48
4.5. Sociodemographic characteristics for participant patients sample .....	49
4.6. Anthropometric characteristics for participant patients sample...	50
4.7. Hydrogen breath test (HBT) for study patients sample .....	51
4.8. Biochemical analysis for patients administered functional blending juice and symbiotic dairy drink for participant patient's sample .....	61
<b>SUMMARY AND CONCLUSION.....</b>	<b>80</b>
<b>REFERENCES .....</b>	<b>83</b>

## IV

### LIST OF TABLES

<b>Table No.</b>		<b>Page</b>
4.1	Formulation of blends wheatgrass extract and fruit juices..	23
4.2	Formulation of mixed rayeb milk and wheatgrass extract ..	25
4.3	Sensory evaluation of different blends .....	38
4.4	Sensory evaluation of symbiotic dairy drinks .....	40
4.5	Physicochemical characteristics of different functional juices blends and symbiotic dairy drink .....	42
4.6	Antioxidant status of different functional juice blend and symbiotic dairy drink.....	46
4.7	Bacteriological growth observed in cultivated media with extract of WGE, PJ, LJ and their functional blends ....	49
4.8	Sociodemographic characteristics for participants sample.....	50
4.9	The anthropometric characteristics for participants sample.....	50
4.10	Hydrogen breath test (HBT) for study population sample ..	53
4.11	Biochemical analysis for patients administered functional blended juice.....	61
4.12	Biochemical analysis for patients administered symbiotic dairy drink.....	73

## LIST OF FIGURES

Fig. No.		Page
1	Processing steps for pomegranate juice .....	21
2	Processing steps for lemon juice.....	22
3	Processing steps for wheatgrass extract preparation.....	24
4	Flowchart for preparing wheatgrass extract and fruit juice blends .....	25
5	Major operations in the symbiotic dairy drink process.....	26
6	Sensory attributes of different juice blends .....	39
7	Sensory attributes of symbiotic dairy drinks .....	41
8	pH of different functional juice blends and symbiotic dairy drink.....	43
9	Total acidity of different functional juice blends and symbiotic dairy drink .....	43
10	Brix Score of different functional juice blends and symbiotic dairy drink .....	44
11	Antioxidant content of different functional juice blends and symbiotic dairy drink .....	47
12	Scavenging activity of different functional juice blends and symbiotic dairy drink .....	47
13	Body mass index (BMI) of participant's men and women ...	51
14	Hydrogen breath test of different participant groups before and after administration of functional blended juice.....	53
15	Hydrogen breath test curve of participant (G1) before (a) and after (b) administration of functional blended juice.....	55
16	Hydrogen breath test curve of participant (G2) before (a) and after (b) administration of symbiotic dairy drink .....	58
17	Hydrogen breath test curve of participant (G3) control group .....	60
18	Lipid profile before and after administration of functional	62

## VI

	blended juice .....	
19	Blood parameters Hb and WBC before and after administration of functional blended juice .....	66
20	Kidney function parameters (creatinine clearance and BUN) before and after administration of functional blended juice .....	70
21	Liver function enzymes before and after administration of functional blended juice .....	70
22	Lipid profile before and after administration of symbiotic dairy drink .....	74
23	Blood parameters (Hb and WBC) before and after administration of symbiotic dairy drink .....	76
24	Kidney function parameters (creatinine clearance and BUN) before and after administration of symbiotic dairy drink .....	78
25	Liver function enzymes before and after administration of symbiotic dairy drink .....	79

## VII

### LIST OF ABBREVIATIONS

A.O.A.C.	: Association of Official Analytical Chemistry
AA%	: Antioxidant activity
Ab	: Antibodies
Abs	: Absorbance
ADP	: Adenosine diphosphate
AFR	: Adverse food reaction
Al	: Aluminum
AlCl <sub>3</sub>	: Aluminum chloride
ALP	: Alkaline phosphatase
ALT	: Alanine aminotransferase
ANOVA	: Analysis of variance
Apo B	: Apo B lipoprotein
AS	: Allergic asthma
AST	: Aspartate amino transferase
ATP	: Adenosine triphosphate
B	: Beta
BCP	: Bromcresol purple
BMI	: Body mass index
BPS	: Bathophenanthroline disulfonate
BUN	: Blood urea nitrogen
BW	: Body weight
°C	: Centigrade degree
Ca	: Calcium
CAD	: Coronary artery disease
CAE	: Catechin equivalent
CBC	: Complete Blood Count
CFU/ml	: Colony-forming units per milliliter
CI	: Carbohydrate intolerance
CMP	: Casein macro peptides
Cr Cl	: Creatinine clearance
DCA	: Differential clostridia agar

## VIII

DNA	: Deoxyribonucleic acid
DPPH	: 2,2-diphenyl, 1-picryl hydrazyl
ESR	: Erythrocyte sedimentation rate
FAO	: Food and agriculture organization
FBS	: Fasting blood sugar
Fe	: Ferric
Fig	: Figure
FODMAP	: Fermentable oligosaccharides, disaccharides, monosaccharides and polyols
FOS	: Fructooligosaccarhrides
G	: Gram
g/L	: Gram per liter
g/dl	: Gram per deciliter
G-6-P	: Glucose-6-phosphate
G-6-PD	: Glucose-6-phosphate dehydrogenase
GAE	: Gallic acid equivalent
GFR	: Glomerular filtration rate
H <sub>2</sub>	: Hydrogen
H <sub>2</sub> O <sub>2</sub>	: Hydrogen peroxide
HBA1c	: Hemoglobin A1c
HBt	: Hydrogen breath test
HDL	: High density lipoprotein
HDL-C	: High density lipoprotein cholesterol
HGB	: Hemoglobin
HK	: Hexokinase
HO <sup>•</sup>	: Hydroxyl radical
HPLC	: High performance liquid chromatography
IBS	: Irritable bowel syndrome
IBW %	: Ideal body weight percentage
Ig	: Immunoglobulin
IgE	: Immunoglobulin E
K	: Potassium

## IX

kcal	: Kilo calorie
KF	: Kenner fecal agar
L	: Liter
LA-5	: <i>Lactobacillus acidophilus</i>
LDL	: Low density lipoprotein
LDL-C	: Low density lipoprotein cholesterol
LJ	: Lemon juice
LSA	: Laureyl sulphide agar
M	: Mole
µg	: Microgram
µL	: Microliter
mg	: Milligram
mg/dl	: Milligram per deciliter
mg/ml	: Milligram per milliliter
Mg	: Magnesium
MIC	: Minimum inhibitory concentration
ml	: Milliliter
ml/kg	: Milliliter per kilogram
mm/Hg	: Millimeter mercury
Mn	: Manganese
MRS	: De Man, Rogosa and Sharpe agar
MWLA	: Modified wallerstein laboratory nutrient agar
Na	: Sodium
NAD	: Nicotinamide adenine dinucleotide
NADH	: Reduced nicotinamide adenine dinucleotide
NaOH	: Sodium hydroxide
ND	: Not detected
NS	: Non significant
O.D	: Optical density
$O_2^{\bullet -}$	: Superoxide ion
OLED	: Organic light-emitting diode
PJ	: Pomegranate juice