# BIOCHEMICAL STUDIES ON SOME STARCH DERIVATIVES

#### $\mathbf{BY}$

### Zahrat El-Ola Mahmoud Mohamed Mahmoud B. Sc. (Food Science),Fac. of Agric., Cairo University(1999)

#### **THESIS**

Submitted in Partial Fulfillment of The Requirements For M. Sc. Degree

In

Agric. Sci. (Biochemistry)
Faculty of Agriculture
Cairo University

2006

#### **ACKNOWLEDGMENT**

# First and forever I fell always indebted to Allah, the most beneficent and merciful

The author wishes to express her deepest gratitude and appreciation to **Prof. Dr. Mohamed Ibrahim Kobeasy**, professor of Biochemistry, Faculty of Agriculture, Cairo University, for his supervision, encouragement valuable assistance, and helpful advice. He has spared no effort at any time in guiding me to bring this work to its best shape.

I would like to express my deepest thanks to **Dr. Samiha Mohamed Abd El-Salam**, professor of Food Technology, Crops Technology Research Dep., Food Technology Research Institute., for her supervision, valuable help throughout this work, and her unlimited help during preparing and writing this thesis.

Also, I would like to thank **Dr. Aml Mahmoud,** Food Technology Research Institute, Agriculture Research Center, for help and interest.

Thanks are also due to all staff membars in Food Technology Research Institute, Agriculture Research Center.

## **LIST OF CONTENTS**

	Page
1. INTRODUCTION	1
2. REVIEW OF LITERATURE	4
2.1. Constitution of native starch	4
2.2.Modified starches	5
2.3.Chemical modification	6
2.3.1.Preparation	7
2.3.1.1.Acetylation	7
2. 3. 1. 2.Succinylation	11
2.3.1.3.Phosphorylation	14
2.3.2.Chemical composition	17
2.3.3.Properties	20
2.3.3.1.Acetylation	20
2.3.3.2.Succinylation	28
2.3.3.Phosphorylation	31
2.4.Biological effects and nutritional value of chemically	
modified starches	36
2.5.Application or Utilization of modified starch	45
2.5.1.Food industry	45
2.5.2.Use of modified starches as improver and anti staling	
agent in baked products	46

3. MATERIALS AND METHODS	51
3.1. Materials	51
3.1.1. Native starch	51
3.1.2.Commercial wheat flour	51
3.1.3.Animals	51
3.1.4.Kits	51
3.2.Methods	52
3.2.1.Preparation of chemically modified starches	52
3.2.1.1.Acetylated starch	52
3.2.1.2.Succinylated starch	52
3.2.1.3.Phosphorylated Starch	53
3.2.2.Determination of degree of substitution (D.S.) of acetylated and succinylated starch	54
3.2.3.Quantitative determination of phosphorus content	55
3.2.4.Chemical composition	57
3.2.4.1. Determination of moisture	57
3.2.4.2. Determination of ash	57
3.2.4.3. Determination of crud fat	57
3.2.4.4. Determination of crude protein	57
3.2.4.5.Determination of amylose and amylopectin content of native and modified corn starches	58
3.2.5.Functional properties	59
3.2.5.1. Water absorption capacity (WAC)	59

3.2.5.2. Swelling power and Solubility	60
3.2.5.3. Apparent viscosity	61
3.2.5.4. Pasting properties	61
3.2.6.Biological evaluation	62
3.2.6.1. Experimental animals	62
3.2.6.2. Determination of serum glucose	68
3.2.6.3. Determination of total lipids pattern	69
3.2.6.3.1.Determination of total lipids	69
3.2.6.3.2.Determination of total cholesterol	71
3.2.6.3.3.Determination of triglycerides	72
3.2.6.3.4.Determination of high density lipoprotein	
cholesterol	74
3.2.6.3.5.Determination of low density lipoprotein	
cholesterol	76
3.2.6.4.Determination of liver function	77
3.2.6.4.1Determination of total protein in serum	77
3.2.6.4.2.Determination of serum transaminases activities	78
3.2.6.5.Determination of kidneys function	81
3.2.6.5.1.Determination of uric acid in serum	81
3.2.6.5.2.Determination of serum urea	83
3.2.6.5.3.Determination of serum creatinine	85
3.2.7.Technological methods	86
3.2.7.1.Rheological properties of wheat flour dough formulas	86

3.2.7.2. Incorporation of starches in pan bread	87
3.2.7.3. Sensory evaluation for pan bread by panel test	88
3.2.7.4.Determination of alkaline water retention capacity	88
3.2.8.Statistical analysis of the data	89
4. RESULTS AND DISCUSSION	90
4.1. Chemical composition of native and modified	
corn starch	90
4.2. Functional properties	93
4.2.1. Water absorption capacity( WAC )	93
4.2.2. The swelling power and solubility	94
4.2.3.Apparent viscosity	98
4.2.4. Pasting properties	99
4.3. Biological evaluation	104
4.3.1.Biological effects of chemically modified starches	
on body weight gain of normal, diabetic and hypercholesterolemic rats	104
4.3.2.Effect of feeding different diets on organs weight of normal, diabetic and hypercholesterolemic rats	108
4.3.3.Effect on blood glucose of normal and diabetic rats	114
4.3.4.Effect on lipid fractions of normal, diabetic and hypercholesterolemic rats	119
4.3.5.Effect on kidney function of normal, diabetic and hypercholesterolemic rats	128

4.3.6.Effect on liver functions of normal, diabetic and	
hypercholesterolemic rats	135
4.4. Technological evaluation	145
4.4.1.Effect of chemical modified starch addition on the rheological properties of wheat flour dough	145
4.4.2. Effect of adding chemical modified starch on sensory characteristics of pan bread	148
4.4.3.Effect of adding chemical modified starch on specific volume of pan bread	151
4.4.4. Effect of chemical modified starch addition on staling pan bread	153
5. SUMMARY	156
6. REFERANCES	161
ARABIC SUMMARY	

### **LIST OF FIGURES**

		Page
Fig. (1)	Design of experiment	69
Fig. (2)	Blood glucose level (mg/dl) in normal rats fed on diets containing 10% chemical modified starches	117
Fig. (3)	Blood glucose level (mg/dl) in diabetic rats fed on diets containing 10% chemical modified starches	118
Fig. (4)	Triglycerides, total cholesterol, HDL-cholesterol, LDL-cholesterol and total lipids, levels (mg/dl) in normal rats fed on diets containing 10% chemical modified starches.	125
Fig. (5)	Triglycerides, total cholesterol, HDL-cholesterol, LDL-cholesterol and total lipids, levels (mg/dl) in diabetic rats fed on diets containing 10% chemical modified starches.	126
Fig. (6)	Triglycerides, total cholesterol, HDL-cholesterol, LDL-cholesterol and total lipids, levels (mg/dl) in normal control and hypercholesterolemic rats fed on diets containing 10% chemical modified starches.	127
Fig. (7)	Urea, uric acid, and creatinine levels (mg/dl) of normal rats fed on diet containing 10% chemical modified starches.	132

Fig. (8)	Urea, uric acid, and creatinine levels (mg/dl) of diabetic rats fed on diet containing 10% chemical modified starches	133
Fig. (9)	Urea, uric acid, and creatinine levels (mg/dl) of hypercholesterolemic rats fed on diet containing 10% chemical modified starches	134
Fig. (10)	Total protein (g/dl) in normal rats fed on diets containing 10% chemical modified starches.	139
Fig. (11)	Total protein (g/dl) in diabetic rats fed on diets containing 10% chemical modified starches.	140
Fig.	Total protein (g/dl) in hypercholesterolemic rats fed on diets containing 10% chemical modified starches.	141
Fig. (13)	Activities of ALT, AST (IU/I) in normal rats fed on diets containing 10% chemical modified starches.	142
Fig. (14)	activities of ALT, AST (IU/l) in diabetic rats fed on diets containing 10% chemical modified starches.	143
Fig. (15)	Activities of ALT, AST (IU/l) in hypercholesterolemic rats fed on diets containing 10% chemical modified starches.	144

## **LIST OF TABLES**

		Page
Table (1)	Composition of the basal diet	63
Table (2)	Composition of salt mixture	63
Table (3)	Composition of vitamin mixture	64
Table (4)	Score sheet of sensory evaluation of pan bread.	88
Table (5)	Chemical composition of native corn starch and chemically modified	
Table (6)	starches Water absorption capacity (WAC) of native and chemically modified	91
	starches	94
Table (7)	Swelling power and solubility in water for native and chemically	
	modified starches	96
Table (8)	Apparent viscosity of native and	
	chemically modified starches	99
Table (9)	Pasting properties for native and	
	chemically modified starches	100
<b>Table</b> (10)	Initial body weight, final body weight	
	and gain in body weight (g) of	
	normal control and rats groups fed	
	on 10% chemical modified starches	105
<b>Table</b> (11)	Initial body weight, final body weight	
	and gain in body weight (g) of	
	normal control and diabetic rats	
	groups fed on 10% chemical	
	modified starches.	105
<b>Table (12)</b>	Initial body weight, final body weight and	
	gain in body weight (g) of normal control	
	and hypocholesterolemic rats groups fed on	107
Table (12)	10% chemical modified starches.	106
<b>Table</b> (13)	Effect of feeding modified starches on organs weight of normal rats.	111
	VI CHIN II VICII VI IIVI IIII I UUI	

<b>Table (14)</b>	Effect of feeding modified starches on organs weight of diabetic rats.	112
<b>Table</b> (15)	Effect of feeding modified starch on organs weight of hypocholesterolemic	
<b>Table</b> (16)	rats. Blood glucose level (mg/dl) in normal rats fed on diets containing 10% chemical modified starches	<ul><li>113</li><li>115</li></ul>
<b>Table</b> (17)	Blood glucose level (mg/dl) in diabetic rats fed on diets containing 10% chemical modified starches	116
<b>Table</b> (18)	Triglycerides, total cholesterol, HDL-cholesterol, LDL-cholesterol and total lipids, levels (mg/dl) in normal rats fed on diets containing 10% chemical modified starches.	122
<b>Table (19)</b>	Triglycerides, total cholesterol, HDL-cholesterol, LDL-cholesterol and total lipids, levels (mg/dl) in diabetic rats fed on diets containing 10% chemical modified starches.	123
<b>Table (20)</b>	Triglycerides, total cholesterol, HDL-cholesterol, LDL-cholesterol and total lipids, levels (mg/dl) in normal control and hypercholesterolemic rats fed on diets containing 10% chemical modified	123
<b>Table</b> (21)	starches. Urea, uric acid, and creatinine levels (mg/dl) of normal rats fed on diet	124
<b>Table</b> (22)	containing 10% chemical modified starches Urea, uric acid, and creatinine levels (mg/dl) of diabetic rats fed on diet	130
<b>Table</b> (23)	containing 10% chemical modified starches Urea, uric acid, and creatinine levels (mg/dl) of hypercholesterolemic rats fed on diet containing 10% chemical modified	130
	starches	131

<b>Table (24)</b>	Total protein (g/dl), activities of ALT, AST (IU/l) in normal rats fed on diets containing 10% chemical modified starches	137
<b>Table (25)</b>	Total protein (g/dl), activities of ALT, AST (IU/l) in diabetic rats fed on diets containing 10% chemical modified starches.	137
<b>Table (26)</b>	Total protein (g/dl), activities of ALT, AST (IU/l) in hypercholesterolemic rats fed on diets containing 10% chemical modified starches.	138
<b>Table (27)</b>	Farinograph parameters of wheat flour (72% extraction rate) and its blends with modified starches	147
<b>Table (28)</b>	Effect of adding chemical modified starches on sensory characteristics of pan bread.	150
<b>Table (29)</b>	Effect of chemical modified starches addition on specific volume of pan bread	152
<b>Table (30)</b>	Effect of chemical modified starches addition on staling pan bread	154