

Dedication

To my Father

And my Beloved Mother

To who was beside me at all time

My husband

Dear sisters & brother

To my sons

&

To my friends Marwa & Safaa

Acknowledgements

Special praise and thanks to Almighty **ALLAH** who has led me thus far in my educational career, and for innumerable bounties.

I would like to express my gratitude and deep appreciation and recognition to my supervisor **Prof. Dr. Ahmed El-Awad El-Faki**, who has provided continuous support, guidance and criticism.

My appreciation to **Prof. Dr. Warda Shakartalla** , Food Reserch Centre, for valuable advice and guidance. Special thanks to **Dr. Barka Mohmed Kabeir** for help and support.

I would like to say thank you with my pleasure to my dear friend Marwa Yagoub.

Very special thanks for everyone who helped me and supported me with samples and materials in cheese plants.

Thanks go to staff of Food Research Center for help in production and all analysis of cheese.

Special thanks and genuine gratitude are extended to my family and my husband for patience, encouragement and support during my study.

LIST OF CONTENTS

Title	Page. No
Dedication	I
Acknowledgments	II
List of contents	III
List of tables	IV
List of figures	V
Abstract	VI
Arabic Abstract	VII
CHAPTER ONE: INTRODUCTION	
Introduction	1
CHAPTER TWO: LITERATURE REVIEW	
2.1 Cheese	4
2.1.1 Historical aspects	5
2.1.2. Definition of cheese	7
2.1.3 Cheese production and consumption	8
2.1.4 Cheese manufacture in the world	11
2.1.4.1 Raw materials	20
2.1.4.2 Method of cheese manufacturing:	14
2.1.5 Quality control of cheese manufacturing.	17
2.2 Cheese making in Sudan	20
2.2.1 Introduction	20
2.2.2. The history of cheese making in Sudan	21
2.2.3. Varieties of Sudanese cheese	22

Title	Page. No
2.2.4. Sudanese white soft cheese Jibna Beyda	23
2.2.5 Method of manufacture of Jibna Beyda	24
2.2.6 The chemical composition of (Jibna Beyda)	28
2.2.7 The microbiology of the Sudanese white cheese	29
2.2.8 Quality control of Sudanese cheese manufacturing	30
2.2.9. Sudanese standards of white cheese	31
2.2.10. Problems facing Sudanese cheese processing	32
2.3 HACCP	34
2.3.1 Background	34
2.3.2 History of haccp	36
2.3.3 Definitions	36
2.3.4 Benefits of haccp	38
2.3.5 Developing of haccp	39
2.3.5.1 Assemble the haccp team	40
2.3.5.2 Product description and its distribution	40
2.3.5.3 Intended use description	41
2.3.5.4 A flow diagram development	42
2.3.5.5 Flow diagram verification	42
2.3.6 HACCP principles	43
2.3.6.1 Hazard analysis conduction (Principle 1)	44
2.3.6.2 Critical control points (CCPs) determination (Principle 2)	45
2.3.6.3 Critical limits establishment (Principle3)	46
2.3.6.4 Monitoring procedures establishment (Principle 4)	47
2.3.6.5 Corrective action procedures establishment (Principle 5)	50

Title	Page. No
2.3.6.6 Verification procedures establishment (Principle 6)	50
2.3.6.7 Record-keeping and documentation procedures establishment (Principle7)	51
2.4 HACCP in cheese	52
2.4.1 Application of haccp system in cheese making	53
2.4.2 Maintenance of the haccp system	55
CHAPTER THREE: MATERIALS AND METHODS	
3.1 Materials	58
3.1.1 Cheese materials	58
3.1.2 Sample collection	58
3.1.3 Chemicals and reagents	59
3.2 Methods	59
3:2:1 Cheese processing	59
3.2.2 Laboratory cheese processing	60
3.2.2.1 Chemical analysis	60
3.2.2.2 Microbiological analysis	64
3.2.3 Haccp checklist	67
CHAPTER FOUR: RESULTS AND DISCUSSION	
4.1 Haccp checklist	70
4.1.1 Company information of processing cheese plants	70
4.1.2 Product information in cheese processing factories	71
4.1.3 Process information features in cheese processing factories	72
4.1.4 Dangers, risks and preventive measures in cheese processing factories	73

Title	Page. No
4.1.5 Haccp decision tree application to each step in cheese processing factories	74
4.1.6 Features of critical limits and tolerances in cheese processing factories	75
4.1.7 Monitoring critical process parameters in cheese processing factories	75
4.1.8 Features of corrective actions in cheese processing factories	75
4.1.9 Features of verifications procedures in cheese processing factories	76
4.1.10 Features of record keeping and documentation in cheese processing factories	76
4.2 Identification of possible hazards and corresponding control measures	77
4.2.1 Raw milk	77
4.2.1.1 Chemicals analysis	77
4.2.1.2 Microbial analysis	79
4.2.2 Pasteurized milk	80
4.2.2.1 Chemical analysis	81
4.2.2.2 Microbial analysis	83
4.2.3 Curds	85
4.2.3.1 Chemical analysis	86
4.2.3.2 Microbial analysis	87
4.2.4 Cheese before storage	88
4.2.4.1 Chemical analysis	89
4.2.4.2 Microbial analysis	91
4.2.5 Cheese after storage	92
4.2.5.1 Chemical analysis	93
4.2.5.2 Microbial analysis	94

Title	Page. No
CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS	
5.1 Conclusion	97
5.2 Recommendations	97
REFERENCE	99
APPENDICES	114

LIST OF TABLES

Table No.	Title	Page No.
Table (1)	First Recorded Date for Some Major Cheese Varieties:	12
Table (2)	The chemical composition of white cheese on dry matter basis	32
Table (3)	Examples of some biological, chemical, and physical hazards in foods	45
Table (4)	Chemicals and microbiological analysis for raw milk	82
Table (5)	Chemicals and microbiological analysis for pasteurized milk	85
Table (6)	Chemicals and microbiological analysis for curd	89
Table (7)	Chemicals and microbiological analysis for cheese before ripening	93

LIST OF FIGURES

Figure No.	Title	Page No.
Fig (1)	Cheese manufacturing Process	18
Fig (2)	Jibna- Beyda preparation	25
Fig (3)	Example of decision tree for process steps	49
Fig (4)	Summary of the HACCP system, (CFIA, 2001).	56

Abstract

This study was conducted in three cheese processing factories beside other two procesery at laboratory scales to dedicate HACCP requirements in Sudanese of white cheese manufacturing. The conducted survey indicates that principle (*Product information features*) is the most applied HACCP principles in cheese processing factories (53.3%), either principles (*Process control and responsibilities for product safety feature, HACCP team feature, Dangers, Risks and preventive*) has been applied weak (45%, 36.4%, 30%), respectively. And principles (*Process information features, HACCP decision tree, Limits and tolerances, Monitoring of critical process parameters*) has been applied very weak (15%, 20%, 10%, 20%), respectively, the study reference that principles (*Corrective actions and Record keeping and documentation*) not-applied in all factories that have been studied. As general it is clear to us that the applied *HACCP* principles on cheese processing factories that have been studied was 22.37% overall.

Milk samples were collected from Khartoum and Gadarif States, Raw milk (A_r and B_r) from Khartoum and (C_r) from Gadarif states. Pasteurized milk (A_p , B_p) from Khartoum and (C_p) from Gadarif. Curd (A_c , B_c) from Khartoum and (C_c) from Gadarif, then the final product (white cheese) before storage (A_b , B_b) from Khartoum and (C_b) from Gadarif, and after storage for a month (A_a , B_a) from Khartoum and (C_a) from Gadarif in addition to the control sample (E_r , E_p , E_c , E_b , and E_a).

Then the chemical and microbial analysis of these samples were carried out, to Identification of possible hazards and corresponding control measures and the results of the chemical analysis as follow, Highest rates of

moisture for all samples as follows (87.2%), (84.2%), (79.6%), (60.0%), (59.89%) for C_r, C_p, B_c, A_b and A_a respectively. And ash ratios recorded (5.16%), (5.0%), (5.0%), (1.96%), (1.6%), (0.85%) for C_a, C_b, B_b, C_c, A_p, and C_r respectively. The highest percentages of protein were (24.5%), (24.0%), (24.0%), (22.02%), (20.5%), and (12.6%) recorded by E_c, A_c, A_p, A_r, E_b, and B_a respectively. The highest percentages of fat were (28.75%), (25.81%), (25.0%) (24.5%), (6.3%), and (6.3%), for B_a, A_p, A_r, E_b, E_c, and A_c respectively, the acidity of all samples were (0.81) (0.25), (0.25), (0.20), and (0.18) for C_b, C_a, B_c, E_p, and A_p respectively. The highest readings of pH were (6.54), (6.53), (6.50), (6.45), and (5.55), recorded B_p, C_r, B_c, E_b, and B_a respectively.

The highest total bacterial count was recorded by sample B_r (5.3×10^5), B_p was (6.10^3), B_c was (5.8×10^3), sample B_b (6.0×10^4), and sample B_a (9.5×10^5). The highest level of coliform was (2×10^2) in sample B_r, pasteurized milk samples were confirmed completely free of this type of bacteria, sample B_b was (1.80×10^2), and sample B_a reading was 11. The highest reading for *E. Coli* for sample B_r (2.0×10^3), and the pasteurized milk, Curd, and Cheese before storage readings recorded that there is no presence of *E. Coli*, and sample B_a reading was 3. *Staphylococcus* bacteria was recorded in sample B_r (1.2×10^2), pasturized milk recorded (0), curd result was (-ve), sample B_b was (5.0×10^3), and the reading (5.0×10^2) was recorded by sample B_a. The yeasts and molds were not recorded in raw and pasteurized milk samples. B_c was (5.0×10^3), sample C_b was (7.0×10^2), sample C_a reading was (9.0×10^4). *Salmonella* results recorded negative readings (-ve) in Raw and Pasteurized milk, but samples C_c, C_b, C_a gave positive reading (+ve).

الخلاصة

أجريت هذه الدراسة في ثلاثة مصانع للجبنه البيضاء، بالإضافة لمعملين متخصصين في صناعة الجبنه البيضاء لقياس مدى تطبيق نظام الهاسب في بعض مصانع الجبنه البيضاء في السودان، تشير الدراسة إلى أن مبدأ (المعلومات الخاصة بالمنتج) هو الأكثر تطبيقاً في مبادئ نظام تحليل المخاطر في مصانع الجبن البيضاء (53.3%)، أما المبادئ (أساسيات التحكم وعمليات سلامة المنتج، مميزات أفراد فريق ال HACCP، تقييم المخاطر الاجراءات الوقائية) تم تطبيقها بنسب ضعيفة بلغت (45%)، (36.4%)، (30%) على التوالي. والمبادئ (ميزات العمليات الانتاجية، شجرة اتخاذ قرارات HACCP، المقدرة والاحتمال، مراقبة السيطرة في النقاط الحرجة) تم تطبيقها بصورة ضعيفة جداً بنسبة (15%)، (20%)، (10%)، (20%) على التوالي. كما اوضحت الدراسة أن (الإجراءات التصحيحية وحفظ السجلات والوثائق) غير مطبقة في جميع المصانع التي تم دراستها. بصورة عامة يتضح لنا من خلال الدراسة أن تطبيق مبادئ نظام تحليل المخاطر في مصانع الجبن التي تم دراستها كان بنسبة (22.37%) بصورة عامه.

تم تجميع عينات الدراسة من ولايتي الخرطوم (A, B) والقضارف (C)، وهذه العينات شملت اللبن الخام ($A_r, B_r, \text{ and } C_r$)، اللبن المبستر ($A_p, B_p, \text{ and } C_p$)، الخثرة ($A_c, B_c, \text{ and } C_c$)، والمنتج النهائي (الجبنه البيضاء) قبل التخزين ($A_b, B_b \text{ and } C_b$) وبعد التخزين لمدة شهر ($A_a, B_a \text{ and } C_a$) بالإضافة للعينات الضابطة ($E_r, E_p, E_c, E_b, \text{ and } E_a$).

وبعد ذلك أجريت التحاليل الكيميائية والميكروبية لهذه العينات، حيث كانت نتائج التحاليل الكيميائية كالآتي:

أعلى نسب رطوبة لكل العينات سجلت كالآتي (87.2%)، (84.2%)، (79.6%)، (60.0%) لكل من Cr, Cp, Bc, Ab على التوالي. ونسب الرماد سجلت (5.16%)، (5.0%)، (1.66%)، (1.6%)، (0.7%) لكل من العينات Ar, Ap, Ca, Cb, Bb, Cc على التوالي. وأعلى نسب بروتين كانت (24.5%)، (24.0%)، (22.02%)، (20.5%)، (12.6%) سجلتها العينات Ba, Ap, Ar, Eb, Ec, Ac ، أما أعلى نسب دهن سجلتها العينات Ba, Ap, Ar, Eb, Ec, Ac وكانت النسب (28.75%)، (25.81%)، (25.0%)، (24.5%)، (6.31%) على

التوالي، الحموضة لكل العينات فكانت (0.81)، (0.25)، (0.25)، (0.20)، (0.18) للعينات C_b ، C_a ، B_c ، E_p ، A_p وأعلى قراءة للأس الهيدروجيني كانت (6.33%)، (6.54%)، (6.45%)، (6.14%)، (5.55%) سجلتها العينات C_r ، B_p ، E_b ، E_c ، A_c ، B_a على التوالي.

أما نتائج التحليل الميكروبي فسجلت النتائج الآتية، العينة B_r (5.3×10^5) سجلت أعلى قراءات للـ Total Bacterial Count، B_p كانت (6.0×10^3)، B_c كانت (5.8×10^3)، وسجلت العينة B_b (6.0×10^4)، أما العينة B_a فسجلت (9.5×10^5). وأعلى مستوى للـ Coliform كان في العينة B_r حيث أعطت قراءة (2×10^2)، أما عينات اللبن المبستر والخثرة (B_p ، B_c) فقد اكدت النتائج خلوها تماما من هذا النوع من البكتيريا، أما العينة B_b فكانت قراءتها (1.80×10^2)، والعينة B_a كانت قراءتها 11. وقد كانت أعلى قراءة للـ *E. Coli* في العينة B_r (2.0×10^3)، أما العينة B_a فقد أعطت قراءة 3، وعينات اللبن المبستر والخثرة والجبنة قبل التخزين سجلت خلوها من وجود بكتيريا القولون. بكتيريا *Staphylococcus* في العينة B_r سجلت (1.2×10^2)، والعينة B_b كانت (5.0×10^3)، أما القراءة (5.0×10^2) سجلتها العينة B_a . وفي عينات اللبن المبستر سجلت القراءة (0)، أما الخثرة فقد سجلت نتيجة (-ve). وقراءات الـ (yeasts and molds) قراءة العينة B_c كانت (5.0×10^3)، وفي C_b كانت القراءة (7.0×10^2)، والعينة C_a أعطت قراءة (9.0×10^4) أما اللبن الخام والمبستر فقد كانت (-ve). نتائج الـ *Salmonella* كانت (-ve) في العينات C_c ، C_b و C_a في حين أنها أعطت نتائج (+ve) في اللبن الخام واللبن المبستر.