Review Article: Bacteriocin Production and its Application in Food and Pharmaceuticals

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Abstract— *Bacteriocins are ribosomal - synthesized antimicrobial peptides that inhibit the growing of pathogenic or deteriorating bacteria. Bacteriocin are a heterogenous group of bioactive bacterial peptides or proteins having variable biochemical properties. Bacteriocin is introduced to denote toxic proteins or peptide produced by any type of bacteria that is active on related bacteria but does not harm the producing cell. They are antimicrobial peptides which are ribosomally synthesized and produced by Lactic Acid Bacteria (LAB). Now days, there are various hazardous effect of chemicals. Instead of chemicals, bacteriocins are mostly effective in food technology which aims to extend food preservation time, treat pathogen diseases, cancer therapy & maintain human health. In food processing, lactic acid bacteria (LAB) shows numerous anti-microbial activities. This is mainly due to production of organic acid, but also of other compound, such as bacteriocin and various peptides. Bacteriocins are used as a potential drug for replacing antibiotics in order to treat multiple drug resistance pathogens. The important mechanism of bacteriocins is pore formation. Bacteriocins are used as food preservation against contaminating organism. It also used against anti-tumor drug in pharmaceutical. They play major role in prevention of human diseases such as cancer, inflammatory diseases, respiratory infection, intestinal disorders, etc. The species of Bacillus, Staphylococcus, Escherichia, Klebsiella, Lactobacillus, Pseudomonas, Proteus are successfully used. These are isolated from vegetables, dairy, cheese, meat and other products. Therefore, Bacteriocin may become a potential drug candidates for replacing antibiotics in order to treat multiple drugs resistance pathogens in the future. Bacteriocin become one of the weapons against micro-organisms due to the specific characteristics of large diversity of structure and function, natural resource and being stable to heat.*

Keywords— Bacteriocin, Lactic acid bacteria, Cancer therapy, Pore formation, Antimicrobial activity.

I. INTRODUCTION

Unlike chemical preservation and antibiotics, generally recognized as safe (GRAS) bacteriocins, such as nisin, promise safe use as food preservation in vegetables, dairy, cheese, meats and other food products, as they inhibit microorganism contamination during the production, process and storage.

1.1 Bacteriocins

There are many antibacterial substance produced by animal, plants, insect and bacteria, such as hydrogen peroxide, fatty acids, organic acid, ethanol, antimicrobial peptides (AMPs) or proteins produced by bacteria are categorized as bacteriocins. Nutrients in the environment trigger microbial production of a variety of bacteriocins for competition of space and resources.

Bacteriocins are abundant, have larger diversity, and the genes encode ribosomally synthesized antimicrobial peptides or proteins, which kill other related (narrow spectrum) or non-related (broad spectrum) microbiotas as one of the inherent defence system weapons of bacteria. They play major role in prevention, of human diseases such as cancer, inflammatory diseases respiratory infection, intestinal disorder, etc.

More than 99 % of bacteria can produce maximum one bacteriocins, most of which are not identified [1]. The Killing ability of bacteriocins is considered a successful strategy for maintaining population and reducing the no. of competitors to obtain more nutrients and living space in environments unlike most antibiotics, which are secondary metabolites bacteriocins are ribosomally synthesized and sensitive to proteases while generally harmless to the human body surrounding environment.

Modern society is more care an healthy of the importance of food safety, as many of the chemical additives used in food many toxic concern, therefore, it is beneficial to claim natural resources and health benefits of natural food without chemical additives have become more popular, and most commercially available preservation and antibiotics are produced by chemical synthesis, and long -term consumption and storage of such product can affect human body as they reduce the counts of bacteria is in a the gut. Moreover, the use of antibiotics or residues in food is illegal. Unlike chemical preservation and antibiotic, generally recognised as safe, (GRAS) bacteriocins, such as nisin, promise safe use as a food, preservation in vegetables, dairy, cheese, meats, and other food products as they inhibit microorganism. Contamination during the production time [**2].**

1.2 Classification of bacteriocins

Classification of bacteriocins from Gram-positive and Gram- negative bacteria.

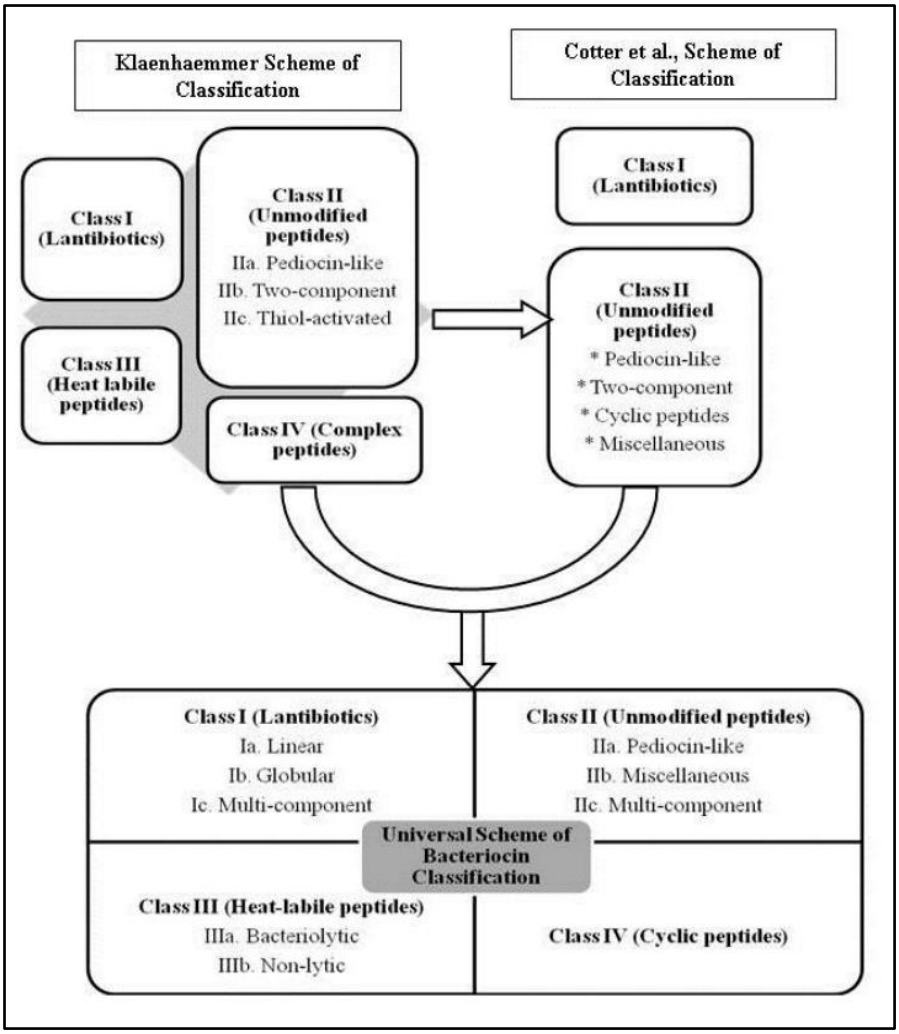

FIGURE 1: Classification of Bacteriocins

Several classification of bacteriocins have been proposed taking into consideration proposed by klaenhammer (1993).

Recently, in order to classify novel bacteriocins, presentation an adjusted classification scheme based on the biosynthesis mechanism and biological activity in accordance with other presentation.

They propose three major classes:-

Class 1:- Small post - translationally modified peptides.

Class 2:- Unmodified Bacteriocins

Class 3:- Heat labile peptide Bacteriocins.

Class 4:- Complex peptides.

1.3 Bacteriocins from Gram -negative bacteria

1.3.1 Colicin

Colicin are antibacterial proteins produced by bacteria, which can kill bacterial strains closely related to produced species.

Classification of colicins by different system :

TABLE 1
CLASSIFICATION OF COLICIN

Colicins	Antibacterial activity	Receptor	Translocators	Molecular weight (Da)	Producing strain
GROUP A					
A	Pore-forming	BtuB	OmpF, TolABQR	62989	*Citrobacter freudii*
E1	Pore-forming	BtuB	TolC, TolAQ	57279	*Escherichia coli*
K	Pore-forming	Tsx	OmpAF, TolABQR	59611	*Escherichia coli*
N	Pore-forming	OmpF	OmpF, TolAQR	41696	*Escherichia coli*
S4	Pore-forming	OmpW	OmpF, TolABQR	54085	*Escherichia coli*
U	Pore-forming	OmpA	OmpF, TolABQR	66289	*Shigella boydii*
28b	Pore-forming	OmpA	OmpF, TolABQR	47505	*Serratia marcescens*
E2	DNase	BtuB	OmpF, TolABQR	61561	*Escherichia coli* *Shigella sonnei*
E7	DNase	BtuB	OmpF, TolABQR	61349	*Escherichia coli*
E8	DNase	BtuB	OmpF, TolABQR	~70000	*Escherichia coli*
E9	DNase	BtuB	OmpF, TolABQR	61587	*Escherichia coli*
E3	16S rRNase	BtuB	OmpF, TolABQR	57960	*Escherichia coli*
E4	16S rRNase	BtuB	OmpF, TolABQR	ND	*Escherichia coli*
E6	16S rRNase	BtuB	OmpF, TolABQR	58011	*Escherichia coli*
DF13	16S rRNase	lutA	OmpF, TolAQR	59293	*Escherichia coli*
E5	tRNase	BtuB	OmpF, TolABQR	58254	*Escherichia coli* *Shigella sonnei*
GROUP B					
B	Pore-forming	FepA	TonB-ExbBD	54742	*Escherichia coli*
Ia	Pore-forming	Cir	TonB-ExbBD	69429	*Escherichia coli*
Ib	Pore-forming	Cir	TonB-ExbBD	69923	*Escherichia coli* *Shigella sonnei*
5	Pore-forming	Tsx	TolC, TonB-ExbBD	53137	*Escherichia coli*
10	Pore-forming	Tsx	TolC, TonB-ExbBD	53342	*Escherichia coli*
D	tRNase	FepA	TonB-ExbBD	74683	*Escherichia coli*
M	Peptidoglycanase	FhuA	TonB-ExbBD	29453	*Escherichia coli*

ND, not determined.

1.3.2 Microcine

Microcine are low molecular weight ribosomal synthesized hydrophobic antimicrobial peptides<10kDa. Which is distinguished by 25-80kda high molecular weight colicins protein.

TABLE 2
CLASSIFICATION OF MICROCINS.

Classification	Characteristics	Microcins	Molecular weight (Da)	Producing strain
Class I	Low molecular weight peptides (<5 kDa), post-translationally modified	B17	3094	*Escherichia coli*
		C7/C51	1177	*Escherichia coli*
		D93	<1000	*Escherichia coli*
		J25	2107	*Escherichia coli*
Class II	Larger (5–10 kDa) peptides, with or without post-translational modifications			
class IIa	Required more than one genes to synthesize and assemble functional peptides	L	8884	*Escherichia coli*
		V	8741	*Escherichia coli*
		N/24	7274	*Escherichia coli*
class IIb	Linear peptides with post-translational modifications or not at C-terminal	E492	7886	*Klebsiella pneumoniae*
		M	7284	*Escherichia coli*
		H47	4865	*Escherichia coli*

1.4 Mode of action of bacteriocins

The Proposed mode of action for bacteriocins is an initial binding to the bacterial membrane by electrostatic force between the negatively charged membrane.

Most of the bacteriocins break out the energy potential of sensitive cells, by a forming membrane pores. The best mechanism is pore formation.

1.5 Application of bacteriocins in Foods and Pharmaceutical

Bacteriocins are widely used in food science to food preservation [17], which inhibits the pathogen infection of animal disease [7] and pharmaceutical industry to treatment for cancer therapy against anti-tumor drug [16].

Bacteriocins are considered as natural product because they are peptides or protein produced by bacteria. In many fermented and non-fermented foods.

The main application of bacteriocins in:

1. Probiotics.
2. Cancer therapy.
3. Food preservation.
4. Drug resistance.

1.5.1 Probiotics

The Probiotic is generally considered to promote the balance of intestinal microbiota and increase the health benefits. The characteristics of Probiotics should include a group of strains beneficial to the host animals that can stably survive and have metabolic in intestinal environment. Probiotic demonstrate the capability of antimicrobial substance production, competitive exclusion of pathogen binding computation for nutrients and modulation of the immune system (FAO & WHO 2001).

Antimicrobial substance such as bacteriocins is produced by Probiotics for inhibiting gastrointestinal microorganisms or pathogens [14]. Bacteriocin produce Probiotic, can reduce the number of pathogen in animal model, such as mice, chikens, & pigs [8].

In many food product such as traditional European cheese, the milk is used in manufacturing process is easily contaminated with animal Excrement (waste matter).

1.5.2 Cancer therapy :-

Cancer has become serious problem and threat to human health. In cancer therapy some researches indicates that bacteriocin shows against tumor cells. Bacteriocin may be suitable as a potential anti -tumor drug. Some bacteriocin such as pore - forming colicin A and E1 inhibited the growth of human standard fibroblast line MRCs and 11 human tumor cell line [**9]**. In recent study [15] found the nisin had capability to prevent cancer therapy.

1.5.3 Food technology

Food preservation are incorporated into food to delay to microbial growth and possible corruption. Bacteriocins are produced by gram positive and gram negative gene encoded peptides or protein. Suitable to natural preservation in food products.

In food technology, nisinis produced by *Lactococcus lactic* and was the first antimicrobial peptides found in LAB [19]. Bacteriocins are used as food preservation against contamination by microorganism. It is any bacteriocin approved for utilization as preservation in many foods by the U. S food and Drug administration. Bacteriocins are used to extend food preservation time, treat pathogen diseases & maintain human health.

1.5.4 Drug Resistance

The first antibiotics penicillin was discovered in 1928 by Alexander Fleming. The problem with multiple drug resistance pathogens has become increasingly serious, regarding of antibiotics [18].

Bacteriocin is reported to inhibit important animal and plant pathogens such as shigo toxin producing *E coli, Staplococcusaurus* [12].

bacteriocins are mainly located in receptor binding of bacterial surface & through the membrane which cause bacteria cytoxicity. Bacteriocins are low-toxic peptides or proteins sensitive to protease, such as trypsin & pepsin [11]. Other bacteriocins, potential when applied to replace antibiotics in Poultry & other animal feeds.

II. CONCLUSION

Bacteriocins are considered as natural product because they are peptides or protein, which has different types, isolated from various sources, including plants. Among them, LAB is selected for bacteriocin production and their antimicrobial activity against microorganisms or pathogens i. e (*Bacillus coagulans, E. coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae, Proteus vulgaris*). Thus, bacteriocin has potential to inhibit the growth of pathogen or deteriorating bacteria. Thus, bacteriocin has been used to preserve food against contamination by microorganisms. Antimicrobial substances such as bacteriocin are produced by probiotics for inhibiting gastrointestinal microorganisms or pathogens. Thus, in disease control, bacteriocin can solve some of the most challenging problems of multi-drug resistant pathogens such as multifunctional bacteriocin, which are more powerful in functionality and germicidal range. As a result they can be widely used in food, animal husbandry and medicine.

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