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Original Research

Efficacy of purified bacteriocin of *L. fermentum* L2 in preservation of plum (*Prunus domestica*) pulp and ready to serve (RTS) plum drink

Abstract

Bacteriocin is used as a preservative in food to curb growth of spoilage and pathogenic bacteria. This study investigated the efficacy of bacteriocin from *Lactobacillus fermentum* L2 (NCBI accession no. MF443392) to enhance the shelf-life of plum (*Prunus domestica*) pulp and a ready to serve (RTS) plum drink. Bacteriocin produced from *Lactobacillus fermentum* L2 was isolated from lassi – a mild, acidic and refreshing buttermilk drink from the Trans-Himalayas. *Lactobacillus fermentum* L2 produced a bacteriocin of molecular weight 5 kDa which showed an antagonistic action against *Staphylococcus aureus*. The bacteriocin, with activity units 10×10^3 AU/ml, was added to plum pulp and its RTS drink as a preservative.

The preservative effect of bacteriocin was studied for a period of 30 days and was compared with the preservative effects of sodium benzoate. The comparative study considered changes in the physicochemical characteristics of processed products and assessed microbial load during the storage period. Non-significant changes were observed in physicochemical characteristics of both products.

Bacteriocin from *L. fermentum* L2 was satisfactory in controlling the growth of *Staphylococcus aureus* and is proven to be a desirable bacteriocin to be used as a natural preservative. The bacteriocin of *L. fermentum* L2 will be checked against multidrug resistance strains – a growing problem against which researchers are looking for alternative solutions.

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Introduction

Consumer apprehension about the increased consumption of foods containing additives formulated with chemical preservatives has fuelled a higher demand for biopreservation. Biopreservation is the general term for methods of food preservation that use microbial actions to impede the growth of spoilage and pathogenic microbes. Any biopreservative used commercially must meet strict standards: it should be non-toxic and certified by recognized authorities; it should not have a deleterious effect on the organoleptic properties of the product; it should be economical to industries; it should have storage stability before use and be sufficiently stable; it should be effective at a relatively lower concentration and should not have any medicinal properties [1].

Biopreservation of food, especially utilizing lactic acid bacteria (LAB), which are capable of inhibiting food spoilage microbes and imparting a unique flavour and texture to food, has been practiced since the early ages, at first unconsciously but eventually with an increasingly robust scientific foundation [2, 3]. The increasing interest in naturally produced antimicrobials, especially bacteriocin, has raised the curiosity of scientists and industrialists globally creating a surge in research on bacteriocin production, purification, genetics and applications [4].

Bacteriocins can be considered designer drugs that target specific bacterial pathogens [5]. These are ribosomally synthesized antimicrobial peptides (of 30–60 amino acids) or proteinaceous compounds with a narrow to wide antibacterial spectrum. The antibacterial compound is heat stable and the producer strain displays a degree of self-protection specific to its own antibacterial peptide. Bacteriocins are protein molecules synthesized for various lineages of gram-positive and gram-negative bacteria when exposed to stressful conditions. Bacteriocins have been characterized as molecules of high antimicrobial property even at low concentrations, provoking the microbial survival inhibition by antibiosis. Most of the bacteriocins are small, basic and amphiphilic in nature and have a narrow broad-spectrum of activity against antibiotic resistant bacteria [6]. These also exhibit diverse molecular structures, molecular masses, thermostability, pH ranges of activity and genetic determinants [7]. So far, only a few bacteriocins, namely nisin and pediocin, are commercially produced. However, nisin is the only bacteriocin that is approved as a food preservative in many countries [8]. New bacteriocins and bacteriocin-producing strains need to be discovered for wider application in food.

Though chemically preserved foods are successful to some extent, their quality is not as satisfying as fresh foods. Hence, a natural alternative is required and bacteriocins serve the purpose [9]. The majority of bacteriocin producers are natural food isolates, which makes them well suited for food applications [10].

Application of bacteriocin in food preservation may help to reduce the use of chemical preservatives, intense heat and other physical treatments for extending the shelf-life of food. It may also satisfy consumer demand for foods that are fresh in taste, ready to eat and lightly preserved. Moreover, bacteriocins, being proteinaceous in nature, do not have any residual effect, contrary to chemical preservatives which are highly health hazardous in nature. Chemical preservatives i.e. nitrates, benzoates, added sulphates, sorbates and formaldehydes have been reported to cause serious health hazards such as hypersensitivity, asthma, neurological damage, multiple sclerosis cardiac diseases and cancer [11].

The isolation of novel bacteriocinogenic microorganisms from fermented ethnic food sources, namely, purification, characterization and application of bacteriocin may be an approach to replace the use of harmful chemicals [11] and practices in food preservation.

This study investigated the use of purified bacteriocin of *Lactobacillus fermentum* L2 to enhance the shelf-life of plum pulp and its RTS. The potential of purified bacteriocin was tested in these processed products in the presence of *Staphylococcus aureus* – an opportunistic pathogen that can cause gastrointestinal illness.

Material and methods

This study used plum (*Prunus domestica*) pulp and RTS plum drink to determine the effect of biopreservation during storage.

Bacteriocin from *Lactobacillus fermentum* L2 was isolated from lassi, a refreshing beverage from the Trans-Himalayas. The bacteriocin was purified by single-step gel exclusion chromatography. This thermostable bacteriocin with a molecular weight of 5 kDa and with strong antagonistic potential against *Staphylococcus aureus* was applied to plum pulp and its RTS drink to enhance the shelf-life of these food products by natural means. Each product was treated separately with crude and purified bacteriocin of *Lactobacillus fermentum* L2 and with the chemical preservative sodium benzoate.

The study was conducted to observe the potential of bacteriocin against *Staphylococcus aureus*. Crude and purified bacteriocins were added at 5000 AU/ml each and the chemical preservative sodium benzoate was added in the concentration of 2000 ppm.

Controls were also run in parallel on food products without any added natural or chemical preservative.

The products were kept for storage under refrigerated conditions for 30 days to determine the effect of biopreservation during storage. The quality evaluation of the products was done periodically on day 0, 7, 14, 21 and 30.

Pulp preparation

Ingredients

600 g ripened plum - 200 ml water

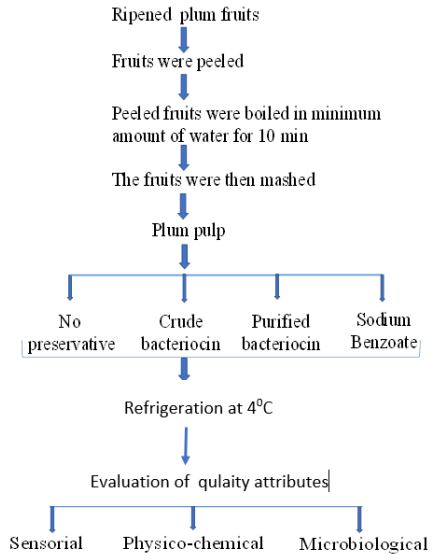

Figure 1 Flow diagram showing pulp preparation and its evaluation

RTS preparation

Ingredients

65 g plum pulp - 52.8 g sugar

545.16 ml water - 1.56 g acid

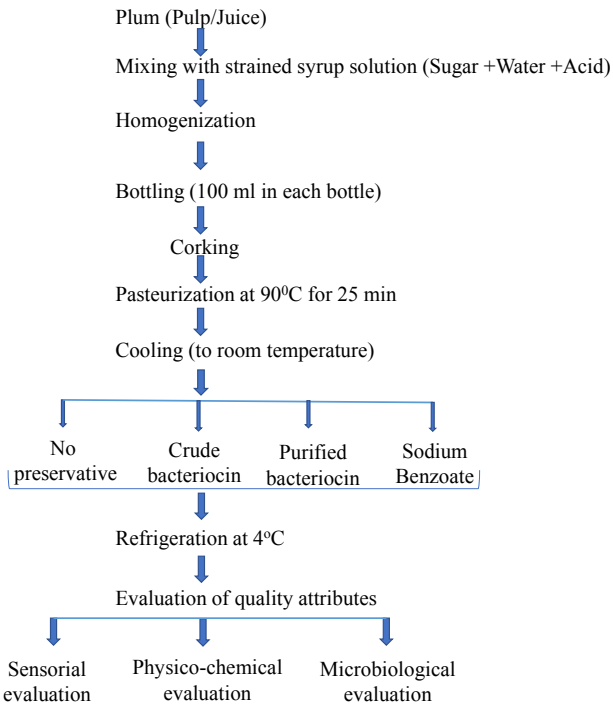

Figure 2 Flow diagram showing RTS preparation and its evaluation

Evaluation of quality attributes

Sensorial evaluation

Sensorial evaluation of plum pulp and plum RTS drink was performed according to the nine-point hedonic scale [12]. A panel of ten judges was selected to evaluate the products for sensory parameters including appearance, flavour, texture, taste, odour and overall acceptability depending upon the type of product. Efforts were made to keep the same panel for sensory evaluation throughout the course of study.

Physicochemical changes during storage

To assess the physicochemical changes in plum pulp and plum RTS, four treatments of each product were evaluated during a storage period of 30 days.

Treatment T1: Product (control)
Treatment T2: Product + crude bacteriocin (5000AU/ml)
Treatment T3: Product + purified bacteriocin (5000AU/ml)
Treatment T4: Product +chemical preservative (2000ppm)

Each treatment and set were subjected to periodical evaluation on day 0, 7, 14, 21 and 30 of the storage period. The following physicochemical changes were observed:

i) pH

pH of each treatment was measured using a pH metre at an interval of 0, 7, 14, 21 and 30 days.

ii) Total soluble solids (TSS)

TSS was measured by placing 1–2 drops of sample on the prism of a hand refractometer. Measurements were recorded on day 0,7, 14, 21 and 30 and the results were expressed as oβ [13].

iii) Acidity in terms of lactic acid

An aliquot of the prepared sample was diluted with recently boiled distilled water. As an indicator, 2–3 drops of 1% phenolphthalein in solution was used and titration was done with 0.1N NaOH. Titre value was noted and calculated as percent anhydrous lactic acid [13].

$$\text{Titratable acidity (\%)} = \frac{\text{Titre} \times \text{Normality of alkali volume made up} \times \text{equivalent weight}}{\text{Volume of sample taken} \times \text{volume of aliquot taken} \times 100} \times 100$$

iv) Ascorbic acid

Ascorbic acid was determined as per AOAC (1995) [14] at day 0, 7, 14, 21 and 30.

Reagents used:

i) 3% metaphosphoric acid (HPO3): Pellets of HPO_3 were dissolved in distilled water.

ii) Ascorbic acid standard: 100 mg of ascorbic acid was weighed and the final volume was prepared up to100 ml with 3% HPO_3. 10 ml of 3% HPO_3 was diluted to 100 ml.

iii) Dye solution: 50 mg of sodium salt of 2, 6-dichlorophenolindophenol was dissolved in 150 ml of hot distilled water containing 42 mg of sodium bicarbonate. It was cooled and diluted with distilled water to 200 ml and stored in a refrigerator.

iv) Standardization of dye: 5 ml of standard ascorbic acid solution and 5 ml of 3% HPO_3. Dye was titrated with the dye solution to a pink colour which persisted for 15 seconds before it disappeared. Dye factor (mg of ascorbic acid per ml of the dye) was determined by following the formula:

$$\frac{\text{Dye Factor}}{\text{Titre}} = 0.5$$

Calculations

The ascorbic acid content of the sample was determined by the following method:

$$\text{mg of ascorbic acid per 100 g or ml} = \frac{\text{titre} \times \text{dye factor} \times \text{volume made up}}{\text{aliquot of extract taken} \times \text{weight of sample taken}} \times 100$$

i) Total carbohydrates were determined using the Anthrone Method [15]. The method is based

on the principle that carbohydrates are first hydrolysed into simpler sugars using dilute HCl. In hot acidic medium glucose is dehydrated to hydroxymethyl furfural. This compound forms with anthrone – a green-coloured product with an absorption maximum at 630 nm.

ii) Total proteins were determined using the method described by Ranganna (2009) [13].

iii) Crude fibres were determined as per the method described in by AOAC (1995) [14].

iv) Free radical scavenging activity (FRSA) was evaluating using the method described by Brand-Williams, Cuvelier and Berset (1995) [16]. DPPH (2, 2-diphenyl-1-picrylhydrazyl) was used as a source of free radical. An aliquot of 3.9 ml of 6×10^{-5} mol/l DPPH in methanol was taken in a cuvette with 0.1 ml of sample extract and the decrease in absorbance was measured at 515 nm for 30 mins or until the absorbance became steady. The remaining DPPH concentration was calculated using the following equation:

Free radical scavenging activity (%) = Ab(b) - Ab(s)

Where:

Ab(b) = Absorbance of blank

Ab(s)= Absorbance of sample

Microbiological evaluation during storage

To study the potential of bacteriocin to enhance the shelf-life of plum pulp and RTS in the presence of the food borne pathogen *S. aureus* four sets were made of each product as described below:

SET-A: Product + *S. aureus* (10^8 CFU/ml)

SET-B: Product + *S. aureus* (10^8 CFU/ml) + crude bacteriocin (5000AU/ml)

SET-C: Product + *S. aureus* (10^8 CFU/ml) + purified bacteriocin (5000AU/ml)

SET-D: Product + *S. aureus* (10^8 CFU/ml) + chemical preservative (2000ppm)

Microbiological evaluation of plum pulp and the RTS drink was done periodically on day 0, 7, 14, 21 and 30 of storage. CFU/ml of each sample was calculated on a nutrient agar medium. The total count was evaluated in terms of log CFU/ml [17].

Statistical analysis

Data pertaining to the physicochemical attributes and data on sensorial evaluation of prepared food product (plum pulp and its RTS) were analyzed by completely randomized design (CRD) factorial as described by O'Mahoney and Dekker M (1986) [18].

Results and discussion

Plum (*Prunus domestica*) is a very important stone fruit of the temperate climate and mid hills of Himachal Pradesh. This reddish purple coloured juicy fruit is rich in vitamins C, A and antioxidants. The shelf-life of plum is short. To avoid post-harvest losses and increase its availability to consumers plums are made into cakes, jams or served as an RTS. They can also be distilled into brandy and liqueur. Considering the nutritional value and health benefits of this perishable fruit, this study prepared plum pulp and RTS and attempted to preserve it by natural means using thermostable bacteriocin (5.0 kDa) *Lactobacillus fermentum* L2, NCBI accession no. MF443392.

Product preservation

Plum pulp and plum RTS were divided into four different sets. Four different treatments (T1 to T4) were applied to preserve them. The study was conducted to compare the preservative potential of crude bacteriocin, purified bacteriocin and sodium benzoate against *Staphylococcus aureus* in these processed products. T1 applied no preservative (control), T2 applied crude bacteriocin L2 (5000AU/ml) as a preservative, T3 applied purified bacteriocin of L2 (5000 AU/ml) as a preservative and T4 applied a chemical preservative (2000ppm). Each set was subjected to periodical evaluation on day 0, 7, 14, 21 and 30 of the storage period.

Nutritional facts of prepared products

Nutritional values including total fat, total carbohydrate, sugar, protein, dietary fibre, sodium, potassium and anthocyanin of prepared plum pulp and RTS were evaluated as shown in **Table 1**. No fat was found in the prepared plum pulp or the RTS. The total carbohydrate was 19.4 g/ml in the pulp and 18.4g/ml in the RTS was. Total sugar was 16.2 g/ml and 14.3 g/ml in pulp and RTS respectively. The protein component was 1.1 g/100 ml in the pulp and 0.9 g/100 ml in the RTS. Dietary fibre content was 2 g/ml in the pulp and 1.6 g/ml in the RTS. Potassium was 230 mg/ml in the pulp and 226mg/ml in RTS. Anthocyanin pigment was 9.5 µmol/ml in pulp and 9.0 µmol/ml in RTS. Similar nutritional compositions for plum products have been reported by Dambalkar, Rudrawar, Poojari (2015) [19].

Table 1 Nutritional chart of plum pulp and RTS

Nutritional facts	Pulp	RTS
Total fat	0	0
Total carbohydrate (g/ml)	19.4	18.4
Total sugar (g/ml)	16.2	14.3
Protein (g/100 ml)	1.1	0.9
Dietary fibre (g/ml)	9.4	1.6
Sodium (mg/ml)	2	0
Potassium (mg/ml)	230	226
Anthocyanin (µmol/ml)	9.5	9.0

Sensorial evaluation of plum pulp and RTS

Freshly prepared plum pulp and RTS samples were assessed by ten panellists using the nine-point sensory hedonic scale for sensory parameters (appearance, texture, taste, odour and overall acceptability), as described by Amerine, Pangborn and Roessler EB (1965) [12]. Both product preparations were almost equally acceptable. The overall acceptability scores for plum pulp and its RTS were 8.3 and 8.42 respectively. Dambalkar, Rudrawar, Poojari VR (2015) performed sensory evaluation of Beetroot orange RTS drink which was assessed in terms of colour, flavour, texture, taste and overall acceptability [20]. Similarly, Pali *et al*. (2020) measured the consumer's acceptability for the fresh blended RTS and beverages by using nine-point hedonic rating test [21].

Physicochemical evaluation

Physicochemical changes in quality attributes of plum pulp during storage

In total, four treatments of prepared products were made: T1, T2, T3 and T4 (as described in material and methods). Prepared plum pulp samples were kept in storage for 30 days and the quality attributes (pH, TSS, titratable acidity and ascorbic acid) of each set were noted on day 0, 7, 14, 21 and 30 of storage as described in **Table 2**.

Table 2 Physicochemical characteristics of plum pulp

Treatments (T)	pH						TSS (°Bx)						Titratable acidity (%)						Ascorbic acid (mg/100g)					
	Storage interval (days)					Mean	Storage interval (days)					Mean	Storage interval (days)					Mean	Storage interval (days)					Mean
	0	7	14	21	30		0	7	14	21	30		0	7	14	21	30		0	7	14	21	30	
T1	4.36	4.00	3.22	3.01	2.38	3.39	9.00	9.00	8.51	8.34	8.22	8.61	1.36	1.59	1.70	1.79	1.90	1.67	9.66	9.62	9.53	9.50	9.37	9.54
T2	4.37	4.25	4.21	4.17	3.10	4.02	9.00	9.00	8.77	8.66	8.37	8.76	1.36	1.47	1.50	1.57	1.62	1.51	9.67	9.64	9.62	9.57	9.55	9.61
T3	4.37	4.26	4.24	4.16	3.13	4.03	9.00	9.00	8.84	8.72	8.57	8.83	1.37	1.47	1.50	1.56	1.62	1.52	9.68	9.65	9.65	9.58	9.55	9.62
T4	4.37	4.24	4.22	4.18	3.11	4.02	9.00	9.00	8.74	8.53	8.46	8.75	1.36	1.48	1.50	1.56	1.62	1.53	9.65	9.66	9.67	9.70	9.67	9.67
Mean	4.37	4.16	3.93	3.79	3.01		9.00	9.00	8.72	8.60	8.41		1.37	1.52	1.58	1.65	1.73		9.67	9.64	9.61	9.58	9.52	

$CD_{0.05}$				
Treatments (T)	0.32	0.40	0.11	0.38
Storage interval (S)	**0.35**	**0.41**	**0.12**	**0.37**
Treatments × Storage interval	**0.11**	**0.16**	**0.01**	**0.14**

pH values slightly decreased during storage. On day 30 the maximum decrease was noticed in T1 (2.38) and the minimum in T3 (3.13). Initially, TSS of plum pulp were the same for all sets (9^0ß) and after 30 days TSS was maximum for T3 (8.57^0ß) and minimum for T1 ($8.22\ ^0$ß). Titratable acidity was measured in terms of lactic acid. Titratable acidity is negatively correlated with pH, that means while pH decreased, titratable acidity increased. The initial lactic acid was 1.36 % for every treatment.

On day 30 of storage lactic acid percentage had increased in T1 to 1.90 % and was equal in T2, T3 and T4 (1.62 %). The ascorbic acid content of plum pulp also showed variation in its values during the storage period. Initially ascorbic acid content ranges in between 9.37 to 9.67 mg/ml in all treatments which rose in every treatment. Changes in quality attributes of plum pulp during storage period were statistically analyzed by CRD factorial which revealed that there are non-significant results of change in quality attributes of plum RTS during storage conditions. [22] performed physicochemical and sensory evaluation of mixed juices from banana, pineapple, passion fruits during storage. They evaluated ascorbic acid, pH, total soluble solid during storage period.

Physicochemical changes in quality attributes of plum RTS during storage

Prepared plum RTS samples were kept in storage for 30 days and the quality attributes (pH, total soluble solid, titratable acidity and ascorbic acid) of each set were noted on day 0, 7, 14, 21 and 30 as described in **Table 3**.

It was observed that pH values slightly decreased during storage. On day 30 the highest pH decrease was noticed in T1 and the lowest in T4. The TSS of plum RTS remained almost the same for treatments T1 to T4 but there was a significant decrease in TSS in T1 (9.18 Bx) whereas minimum decrease was observed in T3 (9.87) during storage for 30 days. Initially all treatments had a TSS of 10^0 Bx. Titratable acidity was measured in terms of lactic acid.

Titratable acidity is negatively correlated with pH which means that while pH decreased, titratable acidity increased. The initial lactic acid was measured to be 0.15% [12] for every RTS treatment. On day 30 of storage T1 had the greatest percentage increase of lactic acid (1.90%) and T3 had the lowest percentage increase (1.57 %). Ascorbic acid content of plum RTS also showed variation in its values during the storage period. Initially, ascorbic acid content was 9.66 mg/ml [12] in all sets. On day 30 of storage the measured minimum ascorbic acid was found in T1 (9.37 mg/100 ml) and the maximum in T4 (9.67 mg/100 ml).

Table 3 Physicochemical characteristics of plum RTS

Treatments (T)	pH						TSS (°Bx)						Titratable acidity (%)						Ascorbic acid (mg/100g)					
	Storage interval (days)					Mean	Storage interval (days)					Mean	Storage interval (days)					Mean	Storage interval (days)					Mean
	0	7	14	21	30		0	7	14	21	30		0	7	14	21	30		0	7	14	21	30	
T1	4.36	4.05	3.42	3.06	2.36	3.50	10.00	9.90	9.65	9.34	9.18	9.62	1.36	1.59	1.70	1.79	1.90	1.67	9.66	9.62	9.53	9.50	9.37	9.54
T2	4.37	4.27	4.24	4.19	3.14	4.04	10.00	10.00	9.78	9.67	9.47	9.78	1.36	1.46	1.47	1.52	1.59	1.48	9.67	9.64	9.62	9.57	9.55	9.61
T3	4.37	4.26	4.24	4.19	3.15	4.04	10.00	10.00	9.89	9.77	9.67	9.87	1.37	1.48	1.50	1.55	1.57	1.50	9.68	9.65	9.65	9.58	9.55	9.62
T4	4.37	4.27	4.24	4.20	3.17	4.05	10.00	10.00	9.76	9.56	9.36	9.74	1.36	1.48	1.50	1.57	1.59	1.50	9.65	9.66	9.67	9.70	9.67	9.67
Mean	4.37	4.20	4.03	3.85	3.07		10	10	9.76	9.60	9.42		1.36	1.52	1.60	1.64	1.71		9.67	9.64	9.61	9.60	9.52	

$CD_{0.05}$				
Treatments (T)	0.34	0.45	0.13	0.39
Storage interval (S)	**0.37**	**0.47**	**0.13**	**0.39**
Treatments × Storage interval	**0.13**	**0.21**	**0.02**	**0.15**

Statistical changes in quality attributes of plum RTS during storage period were analyzed by CRD factorial which revealed a non-significant change in quality attributes of plum RTS during storage conditions.

Figure 3 Comparative study to enhance shelf-life of pulp by crude bacteriocin, purified bacteriocin and sodium benzoate

SET-A: Product + *S. aureus* (10^8 CFU/ml)
SET-B: Product + *S. aureus* (10^8 CFU/ml) + crude bacteriocin
SET-C: Product + *S. aureus* (10^8 CFU/ml) + purified bacteriocin
SET-D: Product + *S. aureus* (10^8 CFU/ml) + Chemical preservative

Microbiological evaluation of plum pulp and its RTS

Staphylococcus aureus is a food borne/ spoilage causing pathogen. It produces wide variety of toxins and causes gastrointestinal illness. The control of this pathogen is of social and economic importance Therefore, *Staphylococcus aureus* was selected as a test pathogen in the study as the bacteriocin of *Lactobacillus fermentum* L2 was found to be effective against this deadly pathogen in antagonistic studies. Microbiological evaluation of plum pulp and RTS was performed during day 0, 7, 14, 21 and 30 of storage. In total, four sets of different treatments were inoculated with *Staphylococcus aureus* to microbiologically evaluate the prepared products and to study the potential of bacteriocin to enhance the shelf-life of the products in the presence of *Staphylococcus aureus* (**Figs 3 and 4**).

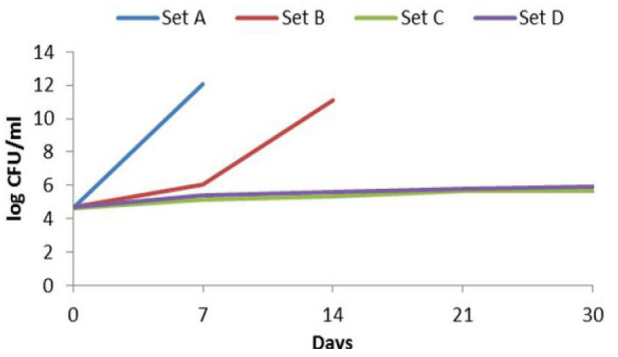

Figure 4 Comparison of crude and purified bacteriocin of *Lactobacillus fermentum* L2 with chemical against *Staphylococcus aureus* to enhance shelf life of plum pulp

During biopreservation studies of plum pulp and RTS it was noticed that the control, i.e. without addition of bacteriocin, showed rapid growth of *Staphylococcus aureus*, leading to spoilage within three days of product formulation. By comparison, crude bacteriocin (Set-B) exerted a preservative effect until day 7. Purified bacteriocin (Set-C) and chemical preservative (Set-D) were found to be the most efficient in controlling the growth of *S. aureus* and keeping the plum pulp preserved until day 30, recording a meagre increase in *S. aureus* log CFU/ml of 5.68 and 5.90 respectively. The same trend was observed during storage studies of RTS. The RTS was preserved until day 30 with a meagre increase in *S. aureus* log CFU/ml of 4.58 and 4.85 respectively (**Fig. 5**). This experiment proves that purified bacteriocin can preserve plum and RTS efficiently and thus can be an alternative to chemical preservatives

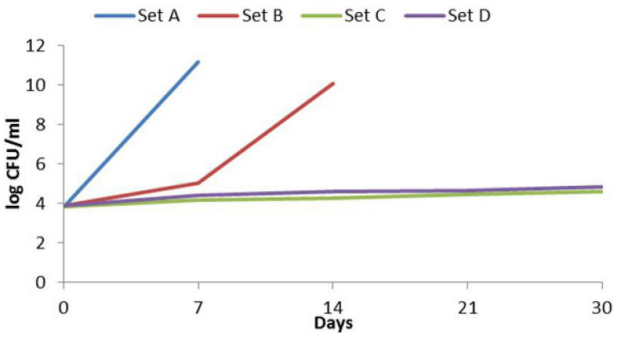

Fig. 5 Comparison of crude and purified bacteriocin of *Lactobacillus fermentum* L2 with chemical preservative against *Staphylococcus aureus* to enhance shelf-life of plum RTS

Similar studies have been conducted by Pei Yue and Jin (2017) in apple juice against *A. acidoterrestris* [23]. Similarly, Mebrouk (2015) reported that metabolites extracted from selected LAB are more effective in preserving tomato paste and sauce stored at 4°C against *E. coli* and that the application of biopreservatives should be encouraged in the food processing industry [24].

Conclusion

This study investigated the efficacy of purified bacteriocin of *Lactobacillus fermentum* L2 as a biopreservative to enhance the shelf-life of plum pulp and RTS plum drink in the presence of food borne pathogen *Staphylococcus aureus*. This heat resistant, low molecular weight bacteriocin can be considered a good alternative for preventing the growth of this deadly pathogen in processed food products. Purified bacteriocin was found to be almost as effective as chemical preservative in comparative studies. These encouraging results suggest that the bacteriocin of *Lactobacillus fermentum* L2 has a strong potential as an alternative to replace synthetic food additives like sodium benzoate for safer preservation.

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