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Use of pasteurization unit for estimation of microbial quality of Iranian non–alcoholic beer using different thermal treatments and various types of packaging

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Abstract

Foods can be stored under good hygienic conditions with the aid of temperature without any chemical conservation. Pasteurization is a time – dependent process and may be an effective method for elimination of microorganisms. The efficiency of pasteurization unit (PU) could be demonstrated by microbiological analyses. The aim of this paper was to find and apply a PU which satisfied, in terms of time and temperature, the necessities of a good and healthy non – alcoholic beer packaged in keg, can, and bottle. The results showed that optimum conditions for pasteurization of non – alcoholic beer in three types of packaging were as follow:
For keg packaging: 85°C for 2s (PU= 124); for bottle packaging: 68°C for 55 min (Min. PU = 200); and for can packaging: 68°C for 35 min (Min. PU= 100).

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Introduction

Beer is among the most popular and widely used beverages worldwide. The concern of most brewers is that the ultimate technique would be the most effective one in terms of product quality, safety and efficiency (Buzrul,2007).Bacteria are both harmful and useful in manufacturing food products. They exert positive effects in the process of manufacturing vinegar, yogurt, beer and even in the synthesis of vitamin K in the human intestine. Harmful bacteria diminish the quality of foods. Although the elimination of all bacteria is not feasible, their number needs to be reduced to an acceptable level so that we would be able to produce safer foods with extended shelf life avoiding an undesirable effect on the foods flavor (Glevitzky *et al.*, 2007). Alcohol-free beer may bear microbial contamination originated from different sources. The primary contamination is originated from raw materials and brew house vessels and the secondary contamination develops through bottling, canning and kegging. While almost half of microbial contamination is associated with secondary contamination, the consequences of primary contamination may be more sever even resulting in destroyed whole product (Vaughan *et al.*, 2005).The pasteurization of beverages with pH<4.5 is made at temperatures smaller than 100°C however the spores are not destroyed. Drinks are sterilized at pH >4.5 at temperatures higher than 121°C destroying all spores, however, drinks only need to be pasteurized because pathogens germs spores could not survive in acidic environment (Glevitzky *et al.*, 2007).

Thermal operation in brewery industry now is run either by flash pasteurization or tunnel pasteurization. In the flash pasteurization, beer is first pasteurized and then packaged in metal kegs. In the latter, the product initially is packaged in bottles or cans and then pasteurized through the pasteurization tunnel (Buzrul,2007).

Pasteurization unit (PU) is used for pasteurization of food products. The number of PU applied for food products depends on the nature of food products depends on the nature of food and specific bacteria (Glevitzky *et al.*, 2007). 1 PU equals to 1 min at 60°C with Z=7 (for microorganisms causing spoilage in beer) (Silva and Gibbs, *et al.*, 2009).

It has been demonstrated that a mild pasteurization is sufficient for stability of carbonated beer, containing alcohol and hop both being natural antimicrobial matters, at ambient temperature (e.g. 20- 120 PU). However, there are concerns about non – alcoholic and less bitter beer (Silva and Gibbs, *et al.*, 2009). Unfortunately as all models, PU also has own limitations. PU, however is a suitable model computed for elimination of not only bacteria but most enzymes (with different Z factors) (Glevitzky *et al.*, 2007).

Lanthoen and Lngledew studied non – alcoholic beer and compared it to 5% v/v alcoholic beer and examined pathogens such as E.coli and S.typhimurium. The results showed that there was a considerable difference in temperature – time relationship required for achieving microbial stability in alcohol – free beer as compared to 5% alcoholic beer (Lanthoen and Lngledew *et al.*, 1996).

At the present a more intense pasteurization (e.g. 120-300 PU) is applied by brewery industry for destroying the microorganisms (Silva and Gibbs, *et al.*, 2009).

Given the microbial problems of beer achieving an optimum PU for retaining microbial quality of non – alcoholic beer final product packaged in keg, can, and bottle is of enormous importance. Excess values of temperature time and thus PU may reduce the nutritional value of beer. Therefore the aim of current research was to investigate the pasteurization pattern of non – alcoholic beer packaged in keg, can, and bottle and find the best optimum values of temperature and PU in order to increase the microbial safety of beer.

Materials and methods

Brewery

Non – alcoholic beer was produced in three steps: 1)

malting (based on barley germination); 2) wort production (mashing, i.e. extraction and hydrolysis of malt components then separation of insoluble components and boiling with hop or hop extract); 3) down – stream processing (filtration, stabilization, bottling, etc.).

Fig 1 shows the steps in non-alcoholic beer production. Also it illustrates a schematic representation of potential sources of microbiological contamination during brewing process (Vaughan *et al.*, 2005).

The physicochemical specifications of non-alcoholic beer produced by above procedure are as follow:
Brix at 20°C = Min. 4.5 (g/100g)
pH= 3.6-4.5
Haze= max. 2 EBC
Co_2= Min. 0.4 (g/100ml).

Pasteurization & Bottling
In order to eliminate microbial contamination of non-alcoholic beer for keg packaging, alcohol-free beer first was flash pasteurized at different temperatures and times (as shown in Table 1) then the kegs were filled with beer. For bottle and can packaging initially they were filled with beer and then pasteurized in the tunnel pasteurizer at different temperatures and times (as shown in Table 2).

Microbial test
Microbial tests included total microbial count for aerobic mesophilic bacteria, mold, yeast, and acidophilic bacteria complying with Iranian National standard No. 6307 (Anonymous, 2001).

Results and discussion
Beer is liable to spoilage by a range of micro-organisms, both bacteria and yeasts. Spoilage results in the formation of hazes, undesirable flavors and aromas. Although beer is rendered unpalatable, the growth of contaminants does not generally lead to health risks. There are some exceptions to this general statement, as discussed later, however pathogenic micro-organisms do not survive in beer (Dennis *et al.*, 2004).

Table 1. Temperature, time and PU for flash pasteurization.

Samples	Tempreture (°C)	Run Time (sec)	PU
Keg	80	2	24
	85	2	124

Table 2. Temperature, time and PU for tunnel pasteurization.

Samples	Tempreture (°C)	Run Time (min)	PU
Bottle	63	55	80 Min
	68	55	200 Min
Can	63	35	50 Min
	68	35	100 Min

Routine microbiological testing in the brewery is usually restricted to enumerating the populations. In many situations, no contamination whatsoever should be detected. In other cases, some contamination is inevitable. Maintaining a record of the numbers of micro-organisms detected provides a useful method of assessing the general cleanliness of the brewery environment, the robustness of cleaning regimes and the microbiological integrity of the process.

Although beer is a microbiologically stable product, unwanted micro-organisms can cause spoilage during the malting and brewing processes. This adversely affects the beer quality; with detrimental financial consequences for the brewing industry. There are

large variations in susceptibilities of beers to microbial spoilage. Beers with low acidity, low alcohol and low carbon dioxide concentrations and beers with added sugar are most prone to spoilage (Vaughan *et al.*, 2005).

The results of microbial tests of current study are presented in Table 3.

Table 3. Results of microbial test for product samples.

samples	Keg(10lit)	Bottle (330cc)	Can (330cc)	Acceptable level
Microorganism (cfu/ml)				
Aerobic mesophilic bacterial	Uncounted	Uncounted	Uncounted	Max20cfu/ml
	3	4	2	
Mold	Uncounted	Uncounted	Uncounted	Negetive
	Negetive	Negetive	Negetive	
Yeast	Uncounted	Uncounted	Uncounted	Negetive
	Negetive	Negetive	Negetive	
Acidophilic bacteria	Uncounted	Uncounted	Uncounted	Negetive
	Negetive	Negetive	Negetive	

Keg packaging

Studying the absence of four type of micro-organisms in keg packaging in two temperatures has shown that a remarkable differences between them.In fact, at 80°c during 2 sec with PU=24 the absence of numerous micro-organisms in non alcoholic beer has revealed that this PU is inadequate for thermal kiling.By comparison, at 85°c during 2 sec with PU=124 non of micro-organisms could survive in the non alcoholic beer. It is clear that PU=124 is more suitable for decomposition of micro-organisms in beer. It can be seen that this PU is a lowest figure which could destroy micro-organisms in keg packaging. A possible explanation for this result may be due to decreasing an overall number of micro-organisms at the same time with increasing temperature pasteurization and PU.

Similar results to the present study have been obtained by Glevitzky *et al.*(2007) who reported that the pasteurization temperature grow and the decrease of microbiological population in juices due to different kind of thermal treatments and also by using the pasteurization units they found the destroy rating of microorganisms in beverages.

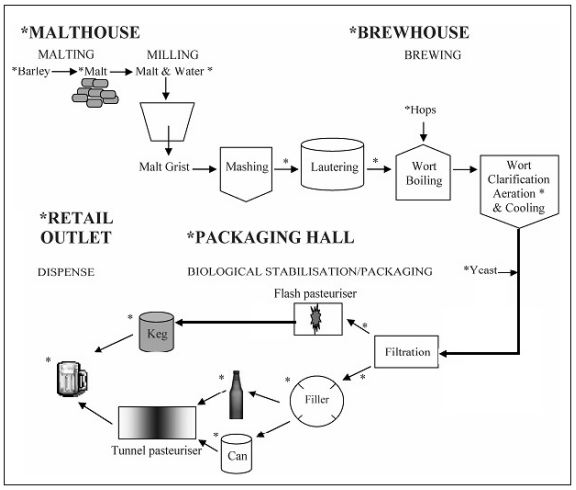

Fig. 1. Basic schematic representation of the brewing process. Potential sources of microbiological contamination are indicated by *.

Can and bottle packaging

In bottle, the determinate PU for decomposition of micro-organisms in two different temperatures (63°c and 68°c during 55 min) was 80 and 200 respectively. The result have shown that we can see an array of micro-organisms in PU=80, but in PU=200 all of the micro-organisms has been killed. As same result could be abtain in can packaging in which PU in two different temperatures (63°c and 68°c during 35 min)

was 50 and 100 respectively. It is clear that PU=100 is more suitable for destroying of micro-organisms in can packaging. All of these results meet the national standard of Iran (Anonymous, 2001).

To sum up, the results revealed that as the PU value increases, the number of microorganism shows a considerable reduction. Also as the results show, PU increases as the temperature increase.

Conclusion

By using PU we are able to monitor the rate of microorganism's elimination in non – alcoholic beer with a non – linear empirical dependence being between pasteurization time and temperature.

On the basis of empirical microbiological data concerned with optimum value of PU the optimum conditions for pasteurization of non – alcoholic beer established in this study for three types of packaging are as follow:

For keg packaging: 85°C for 2S (PU=124); for bottle packaging: 68°C for 55 min (Min. PU=200); and for (Can packaging; 68°C for 35 min (Min. PU=100).

In further research it was found that the time required for destroying microorganisms is shortened exponentially as the temperature is increased slightly. So at higher temperature the microorganisms existing in beer are eliminated within a shorter time (Vaughan *et al.*, 2005). Finally researches are needed to deal with the interactive effects of time and PU in different packaging.

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