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Quality and Yield of Chihuahua Cheese Produced from Dairy Cattle Supplemented with Enriched Apple Byproduct

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Abstract: Solid State Fermented Apple Pomace (AP-SSF) enriched with non-nitrogen protein has been studied as alternative ingredient for feeding dairy cattle. The aim of the present study was to evaluate, the effects of AP-SSF dairy cattle supplementation on yield, sensorial properties and foodborne pathogens on Chihuahua cheese. About 2 groups (treatment and control) of 10 cows were used on a Latin square design (2×2). Treatment animals were AP-SSF supplemented (5% as fed basis) in 2 periods of 20 days rotating with the control group (conventional diet). About 6 samples of milk within each period were used to elaborated Chihuahua cheese. Foodborne pathogens and sensorial properties were analyzed after 8 and 10 days of cheese elaboration, respectively. No effects were observed ($p>0.05$) on microbiological cultures of *Salmonella* sp., *Streptococcus* sp., *Staphylococcus* sp. and total coliforms after 8 days of cheese elaboration. Sensorial properties were affected ($p<0.05$) by AP-SSF supplementation, improving preferred sample, appearance, flavor and texture also, it was better overall qualified. Results suggest that AP-SSF improve sensorial properties of Chihuahua cheese. Moreover, yield and foodborne load was within international dairy federation standards.

Key words: Apple pomace, cheese, solid state fermentation, foodborne pathogens, sensorial properties, Mexico

INTRODUCTION

Cheese origin is controversial, it is estimated that the first cheese was elaborated at 3000 AC years. Nevertheless, inoquity of both milk and cheese was address until the 50 BC years. Since then cheese producers have been working on increase yield and sensorial properties of cheese and decrease risk of foodborne pathogens. The most important are *Salmonella* sp., *Staphylococcus* sp., *Streptococcus* sp. and total coliforms which are within the 28 principal foodborne infections and those are transmittable by milk and milk products (Tauxe, 2002). In industrialized countries, nevertheless technologic levels and food safety programs, Salmonella has been recognized one of the main lethal foodborne pathogen (Altekruse *et al*., 1997). With the objective of increase cheese safety researchers have been proposed the use of preservatives and bacteriostats on cheese elaboration. However, those strategies are expensive and may produce secondary effects like antibiotic resistance and in extreme cases, human hypersensibility (Jones and Seymour, 1988). At the 20 century, research of antioxidant substances increased within this group, it is recognized the poliphenols which have been shown antimicrobial and anti-inflamatory properties (Silveira-Rodriguez *et al*., 2003). Poliphenols have been found in different products including apples in which its concentrations vary from 7-24 mg g^{-1} (Lu and Foo, 1997). Increase on cheese yield has been addressed by increasing milk protein through animal feeding strategies.

As well, fat milk has been used for improvement on cheese texture and flavor (Bauman *et al*., 2006; Jenkins and McGuire, 2006). Apple pomace has been reported to increased fat and protein milk concentrations on dairy cattle (Anrique and Dossow, 2003). Apple pomace has been used for feeding dairy cattle. However, the low protein content of this by-product limits its use. It has been proposed that the inclusion of Non-protein Nitrogen (NPN) to solid state fermented apple pomace increased crude protein from 4-24% (Hernandez *et al*., 2007). Moreover, this fermentation process maintains

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poliphenol levels around 8.4±2.1 mg g^{-1} (DM basis) (Rodriguez-Ramirez, 2009). The aim of this study was to evaluate sensorial properties, foodborne pathogens and yield of Chihuahua cheese produced with milk from dairy cattle supplemented with AP-SSF.

MATERIALS AND METHODS

The study was conducted in the branch El-Pinar located in Zacatecas, Mexico at 22´44° North latitude and 102´22° West longitude. About 20 lactating dairy cows were selected (2-4 lactations) and randomized assigned to 2 treatment groups (10 animals each group) on a 2×2 Latin square design (2 treatment and 2 periods). Control diet was based on corn silage (43%), protein concentrate (24%), corn grain (14%), alfalfa hay (10%), corn hay (4%), oats hay (4%) and mineral/vitamin supplement (1%) with a nutrient profile of 18.2% CP, 15.01% CF, 34.70% NDF, 19.8% ADF, 1.24% Ca and 0.55% of P; treatment diet was the same than control group only adding 5% (AFB) of AP-SSF. Apple pomace-SSF was elaborated by adding ammonium sulfate (0.5%), urea (1.5%) and commercial mineral supplement to (0.5%) to apple pomace and fermented in solid state by 14 days before being used as feed supplement (Becerra, 2006). Adaptation period to diet was 10 days long after that first trial period of 20 days begun and 6 milk samples (0, 4, 9, 13, 16, 20 days) per treatment were taken to elaborate Chihuahua cheese and calculate yield.

Samples taken from each cheese within treatments were used to determined foodborne pathogens (standard plate count) at 8 days after cheese elaboration, bacteria includes *Salmonella* sp., *Staphylococcus* sp., *Streptococcus* sp. and total coliforms (IDF, 1991). Appearance, flavor and texture were used to measure sensorial properties also preferred sample and overall qualification were determined at 10 days after Chihuahua cheese elaboration. Sensorial properties were evaluated by a survey to 100 people per cheese sample, summarizing 600 surveys per period using the discriminate couple technique (Chamorro and Losada, 2002). At the end of the 1st trial period, diets and group of animals were exchanges, meaning that control group of animals were now supplemented with AP-SSF and viseversa with the same adaptation and sample time procedure. Statistical analysis for variables, cheese yield and foodborne pathogens load of *Salmonella* sp., *Staphylococcus* sp., *Streptococcus* sp. and total coliforms were calculated using an ANOVA with main effects of treatment and period of time. For sensorial results analysis, it was used the Student t test. All statistical analysis was completed using the SAS (2002) software.

RESULTS AND DISCUSSION

No effects ($p>0.05$) on yield of Chihuahua cheese were observed with the addition of AP-SSF (Fig. 1). Moreover, yield was within international parameters obtaining 1 kg of cheese per ~10 L of milk (Banks, 1990; Villegas, 2004). The addition of AP-SSF was not enough to increase milk protein levels, those levels have been reported to increase cheese yield (Bauman *et al*., 2006; Gutierrez-Pina, 2007). Feed antioxidants are excreted within milk and significantly maintained in cheese (Pizzoferrato *et al*., 2007). In the present study, it was hypothesized that polyphenol level of Chihuahua cheese decrease bacteriological count of foodborne pathogens. Results shown that microbial load of *Salmonella* sp., *Staphylococcus* sp., *Streptococcus* sp. and total coliforms were unaffected ($p>0.05$) by AP-SSF (Table 1), only numerical differences were observed on the study decreasing bacterial load with the AP-SSF treatment. Moreover, foodborne pathogen ranges for both treatments were within recommendation levels of the (IDF) International Dairy Federation (ISO, 2004) (Table 1). Apple pomace-SSF improved ($p<0.05$) sensorial properties of Chihuahua cheese (Table 2). Nevertheless, no effects were observed with AP-SSF on percentage of fat milk. The AP-SSF enhanced appearance, flavor and texture also cheese was more selected and better overall qualified than the control group cheese. Improvement of sensorial properties can be associated with fat milk

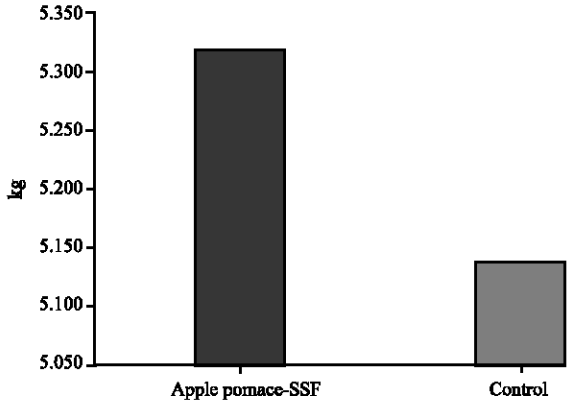

Fig. 1: Effects of apple pomace-SSF on yield (50 L^{-1} of milk) of Chihuahua cheese

Table 1: Effects of apple pomace-SSF on foodborne pathogens load (LSM±SE) of Chihuahua cheese

Items (CFU g^{-1})	Apple pomace-SSF	Control
Salmonella sp.	17±0.3	19±0.6
Total coliforms	31±0.4	32±0.7
Staphylococcus sp.	30±0.5	35±0.6
Streptococcus sp.	17±0.1	24±0.8

No effects for any variable was observed ($p>0.05$)

Table 2: Effects of apple pomace-SSF on sensorial properties of Chihuahua cheese

Items	Apple pomace-SSF	Control
Preferred sample (%)	62.3[a]	37.70[b]
Preferred appearance (%)	58.7[a]	41.30[b]
Preferred flavor (%)	62.8[a]	37.20[b]
Preferred texture (%)	56.7[a]	43.30[b]
Overall qualification 1-10	8.19[a]	7.38[b]

[ab]Columns with unlike superscripts differs ($p<0.05$)

because fat is responsible for different physic properties, production characteristics and organoleptic qualities (Bauman *et al*., 2006). It has been reported that sensorial properties of cheese can be modified due to fatty acid content of fat milk (Lock and Bauman, 2004). Moreover, aldehydes and ketones derived from free fatty acid metabolism are responsible for flavor and aroma cheese and an increment on free fatty acids from triglycerides modified organoleptic properties (Lucey *et al*., 2003) which could explain in part results of the study (Table 2).

CONCLUSION

Results suggest that AP-SSF improved sensorial properties of Chihuahua cheese. More research has to be done to assess the effect of AP-SSF on milk fatty acids.

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