Study of partial substitution of NaCl with KCl on aroma characteristics of UF white cheese

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ABSTRACT

This work was done to estimate some volatile compounds which had important effect on aroma and flavor of low salt UF cheeses. Treatments were prepared as follows: A: 100% NaCl as a control sample; B: 75% NaCl + 25% KCl and C: 50% NaCl + 50% KCl. The aroma compounds which had been measured after 5, 17 and 40 days of ripening period were acetaldehyde, ethanol, diacetyl, acetic acid and acetoin. Effect of treatment and time were significant (P<0.05) during 5, 17 and 40 days of ripening period. Acetaldehyde and ethanol contents of all treatments were decreased during ripening period, although diacetyl of treatment C was increased until 17 days of ripening period and then decreased until the end of ripening period. Acetic acid and acetoin of all treatments were decreased until the end of ripening period. Results obtained from aroma compounds contents showed that treatment B was the best among other treatment.

INTRODUCTION

Salt (sodium chloride) has traditionally been used as a preservative however; functional properties and nutritional considerations are now becoming more important in its use in food processing [1]. There have been positive correlations between average salt consumption and the incidence of hypertension [2]. On the other hand, studies indicate that an increased intake of potassium via the diet can exert a protective effect in individuals with sodium-induced hypertension [3]. It should also be pointed out that increased dietary sodium increases urinary loss of calcium thereby raising the requirement for this mineral [1]; thus, salty foods are considered as a potential risk factor for osteoporosis [1]. In contrast, increasing potassium intake decreases urinary calcium excretion and potentially protects skeletal mass [4]. As result, the dairy industry is seeking ways to reduce the sodium chloride content of cheeses which contain more sodium than do other dairy products [5]. Each type of salt can reduce water activity of foods with due attention to its chemical activity and water activity in foods has an important role to growth of lactic acid bacteria which have objectionable influence on producing of aroma of cheeses.

More than 600 volatile compounds have been identified in different cheese varieties and may have been related to particular odour and aroma notes. In a wide verity of cheeses lactic acid bacteria contribute to cheese flavor through the action of live cells and, when lysis of cells occurs, through the release of their intracellular material, including enzymes such as proteinases, peptidases, amino acid catabolic enzymes and esterases, to the cheese matrix. Spontaneous lysis happens at a slow rate in cheese. Procedures that enhance cell lysis will flavor access of enzymes to their substrates, and may thus accelerate cheese flavor development [6]. UF cheese has a high salt content of 3.4%; this is equivalent to 1338 mg Na per 100 g of cheese, since salt consists of about 39% sodium [7]. In the present paper, the effect of partial substitution of NaCl with KCl on aroma characteristics of UF white cheese is reported.

MATERIAL AND METHODS

Cheese making:

UF white cheese was manufactured from cow’s milk at the pilot plant of dairy industry of chupan factory. Mixture of 3:0 as a control sample(treatment A), 3:1 (treatment B) and 1:1 (w/w) (treatment C) NaCl and KCl.
were used in the salting process of experimental cheeses and the degree of substitution of Na by K in the cheeses was found to be about 0, 25 and 50% respectively. The whole experiment was repeated three times. The cheeses were sampled at 5, 17 and 40 days of ripening. The cheese samples were stored at -18°C before use.

For analysis, grated cheese was placed in a vial (4ml), sealed by a septum-type cap and held in a water bath. During this time, the sample was sometimes shaken to homogenize and to increase the transfer of the analytes to the headspace. After equilibration time, the SPME fibre was inserted in a vial for the sampling process [8].

**SPME:**

The SPME fibrecarboxen™/poly dimethyl siloxane 85 μm was purchased from supelco (Bellefonte, PA, USA). The extraction was carried out by HS-SPME mode.

**Gas Chromatography and Mass Spectrometry (GC-MS):**

Gas chromatograph TRACE™GC (Thermo Quest, I) equipped with flame ionization detection and split/splitless injection port, DB-WAX capillary column (30m ×0.32 mm× 0.5μm; J. & W. Scientific, Folsom, CA). The injector -250 C, splitless mode, the desorption time 5 min, linear purge closed for 5 min. The oven temperature program -40 C for 1 min, 40-200 C at 5 C/min,200 C for 7 min. the detector for 220 C. the carrier gas (N2)0.9ml/min. GC-MS analyses-gas chromatograph GC 8000 (Carlo Erba, I) coupled to a MS TRIO1000 (Fisons instruments, USA). The carrier gas He, the GC column and other operating parameters were the same as described.

**RESULTS AND DISCUSSION**

The acetaldehyde content of UF cheeses are given in figure 1. The acetaldehyde of all cheeses decreased during aging. Acetaldehyde content of control and experimental cheeses had significant differences ($P<0.05$) at all sampling ages. This finding is in disagreement with the result of Vitova et al., (2006) who reported that acetaldehyde of Niva cheese reached maximum in about 40 days. Straight-chain aldehydes may result from ω-oxidation of unsaturated FA or from amino acids by strecker degradation. Branched chain aldehyde probably originates from amino acid degradation via enzymatic as well as non enzymatic, e. g. strecker degradation, processes. The main reason for decreasing acetaldehyde during ripening was attributed to changing it to alcohols because aldehydes are transitory compounds in cheese and they are rapidly reduced to primary alcohols or oxidized to the corresponding acids. They are characterized by green-grass or herbaceous aroma and can be very unpleasant when their concentrations exceed certain values [8].

**Fig. 1:** Changes in Acetaldehyde content of all samples during 40 days of ripening period

The ethanol content of all treatments decreased during ripening period (Figure 2) and there is significant differences ($P<0.05$) among all treatments because primary alcohols are formed by the proper aldehydes reduction. They impart a fruity, nutty note to the cheese flavor, and in certain cheeses high levels of them can cause flavor defect. Secondary alcohols are formed by enzymatic reduction of the corresponding methyl ketones. They have similar but heavier flavor notes than methyl ketones. Ethanol comes from lactose
fermentation. It has a limited role in the cheese aroma despite its high levels, but it contributes to the formation of esters [9].

**Fig. 2:** Changes in Ethanol content of all samples during 40 days of ripening period

Diacetyl content of treatment A and B decreased during ripening period however diacetyl content of treatment C increased until 17 days of ripening period and then decreased at the end of ripening period (Figure3). Diacetyl content of all treatments had significant differences ($P<0.05$). One of the most important diketones is diacetyl (butan-2, 3-dione) with sweet buttery and vanilla aroma. It is formed through lactose and citrate metabolism and its production is mainly due to the activity of lactic acid bacteria. In fact, the activity of lactic acid bacteria increased by reduction Na$^+$ concentration and increasing K$^+$ concentration. These conditions were not suitable for producing diacetyl bacteria like lactobacillus helveticus so diactyle content of treatment C was less than other treatments because of higher potassium content.

**Fig. 3:** Changes in Diacetyl content of all samples during 40 days of ripening period

Acetoine content of all treatment decreased during ripening period (Figure 4). There was significance differences ($P<0.05$) among all treatments. diacetyl can be reduced to acetoine (3-hydroxy butan-2-one) with buttery aroma and acetoine can be further reduced to butan-2,3-diol, which does not have a flavor impact [8]. Acetoine was present at a high concentration in unripe cheese and then its amount sharply decreased.
Acetic acid content of treatment B and C decreased during ripening period however acetic acid content of treatment A decreased until 17 days of ripening period and then increased at the end of ripening period (Figure 5). Acetic acid contents of all treatments showed that there were significance differences ($P<0.05$) among all treatments. Fatty acids are important components of the flavor of many cheese types. They may originate from lipolysis, a lower proportion of short –chain FA originate from the degradation of lactose and amino acids, and they can also be derived from ketones, esters, and aldehydes by oxidation [11]. Long –chain FA (>12 carbon atoms) play a minor role in the flavor owing to their relatively high perception thresholds. Short and moderate-chain, even-numbered FA (C4–C12) have much lower perception thresholds and characteristic notes (vinegar, sour). Moreover, free FA also serve as precursors to methyl ketones, alcohols, lactones, and esters [8]. The slower rate of acetic acid production in the control cheese was attributed to the inhibitory effect of NaCl on lipolysis [10] and cheeses salted with a mixture of NaCl/KCl (1:1) had higher contents of acetic acid than those salted only with NaCl.

**Fig. 4:** Changes in Acetoine content of all samples during 40 days of ripening period

**Fig. 5:** Changes in Acetic acid content of all samples during 40 days of ripening period

**Conclusion:**

The result of this study indicate that an up to 25% reduction of sodium in UF cheese, achieved by partial replacement of NaCl with KCl, had similar quality to control cheese, as measured by the acetaldehyde, ethanol, diacetylene, acetoine and acetic acid, during aging of cheese.

**REFERENCES**