BUTTER - FROM FERMENTATION TO SENSORY PROPERTIES

Darija Bendelja Ljoljić[1] – Leonarda Valentina Mrkoci[1] – Ivan Vnučec[1] – Ivica Kos[1]

[1]Division of Animal Science, Faculty of Agriculture, University of Zagreb, Svetošimunska 25, 10 000 Zagreb, Croatia

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ABSTRACT

Butter is traditionally most commonly made from cow's milk, while butter made from goat's and sheep's milk is common in Mediterranean countries, the Middle East and Africa. The type of milk has a significant influence on the physico-chemical, sensory and nutritional properties of butter, which have not yet been sufficiently researched for goat's and sheep's butter. Production processes, such as churning and ripening of the cream, are key to achieving the desired sensory properties of butter. Butter made from cow's milk has a milder flavour and a firmer texture due to the saturated fatty acids, while butter made from goat's and sheep's milk has a more intense flavour and a softer texture due to the short-chain fatty acids. The flavour of butter is the result of the interplay of production processes, the type of milk, fermentation and the feeding of the animals, while the colour depends on the presence of beta-carotene. The diversity of butter emphasises the importance of understanding the production factors and the potential to expand the market for goat and sheep butter, which could boost their production and consumption.

Keywords: cow's milk, goat's milk, sheep's milk, production process, colour, texture, aroma

INTRODUCTION

Butter, as one of the oldest forms of preserving milk fat, is a key element in food culture worldwide as it is a rich source of energy. According to the Codex alimentarius (2011), it contains at least 80% milk fat, but no more than 90%, and is obtained by churning sweet or sour cream. Butter is most commonly made from cow's milk, but the use of other milks such as goat's, sheep's and buffalo's milk, which have unique sensory and nutritional properties, is increasingly being explored. Although goat and sheep milk products are only common in some Mediterranean countries, the Middle East and Africa, their presence in the literature is still scarce (Deosarkar et al., 2016; Vioque-Amor et al., 2023). The different types of milk have a significant impact on the physico-chemical properties, texture, aroma profile and thus on the sensory characteristics of butter. Considering that sheep and goat milk are mainly used for the production of cheese and yoghurt, research into butter from these milks opens up new possibilities for diversity in nutrition. Differences in the chemical composition, such as the proportion of dry matter, protein, fat and fatty acids, are reflected in the end product. For example, butter made from cow's milk usually contains a higher proportion of saturated fatty acids, which makes it firmer, while butter made from goat's and sheep's milk, which contains more unsaturated fatty acids, has a softer texture (Lee et al., 2020; Lapčiková et al., 2022). In addition to the chemical composition,

the production process, including churning, ripening of the cream (fermentation) and the addition of salt, also plays an important role in shaping the sensory properties of butter (Lis et al., 2021).

The aim of this article is to provide a deeper insight into the complexity and diversity of this traditional dairy product depending on the type of milk and cream, and to raise awareness among producers and consumers of the potential of the lesser-known but nutritionally valuable butter variants made from different types of milk on the market.

THE RIPENING OF CREAM - AN IMPORTANT STEP IN THE PRODUCTION OF BUTTER

For the production of butter, you can use sweet cream, obtained by skimming the milk without fermentation, or sour fermented cream, obtained by the action of butter dairy culture (Mallia, 2008), and so their sensory properties (appearance, odour, texture, flavour and aroma) differ. The ripening of the cream (physical and/or biochemical) plays an important role in determining the quality of the butter, whether in terms of flavour or consistency. In the production of butter, the physical ripening of cream is a mandatory technological process that is carried out to improve the physical properties of the butter. During the physical ripening of the cream, the milk fat undergoes a crystallisation process. If this process is omitted, this can lead to undesirable properties of the butter, for example the fat can separate from the butter. Such butter can be either too hard or too soft, which can lead to increased fat loss in the buttermilk and directly affect the water content of the final product (Deosarkar et al., 2016). Although biochemical ripening of cream, unlike physical ripening, is not mandatory, it ensures the formation of aroma compounds that are crucial for the development of the desired butter flavour (Fearon, 2011). Biochemical ripening of cream is the result of the action of mesophilic butter cultures consisting of *Lactococcus* and *Leuconostoc* strains of lactic acid bacteria, which, in addition to lactic acid, also form aromatic components in the cream (mainly diacetyl and acetoin), which are responsible for the formation of the desired sensory properties of butter.

SENSORY PROPERTIES OF BUTTER

The sensory properties of butter include a number of aspects such as appearance, colour, flavour, aroma, quality during storage and physical properties such as hardness and spreadability.

Appearance and color

Visual characteristics such as colour, size, shape and texture play an important role in consumers' purchasing decisions. In the case of butter, studies have shown that colour and appearance are particularly important for consumer acceptance (Vioque-Amor et al., 2023). Butter should be matt, without shine or greasy sheen, which indicates its freshness and quality (Kashaninejad et al., 2016). The colour of butter is a characteristic that is highly dependent on the type of milk used, but within the same type, the colour can also be influenced by the feeding of the dairy animal. The colour of butter can vary from pale yellow to intense yellow, and this aspect depends largely on the carotenoid content of the milk. Carotenoids are natural pigments found in the food consumed by animals and their content in milk has a direct effect on the final colour of the butter. For example, pigments from the carotenoid group, especially the precursor of vitamin A, beta-carotene, are responsible for

the yellow colour of cow's milk butter (Vioque-Amor et al., 2023). In contrast, sheep's and goat's milk and dairy products made from these types of milk are extremely white in colour due to the insufficient amount of carotenoids (Lee, 2020; Silva et al., 2023). Among other things, the size of the fat globules of the cream used for the production of butter has an influence on the colour of the butter (Vioque-Amor et al., 2023). As sheep's and goat's milk contain a larger number of fat globules with a smaller diameter than cow's milk, their colour is whiter. The colour of butter is also influenced by manipulations during production. Intensive processing, i.e. mechanical manipulation, leads to the formation of smaller water droplets, which determine the pale colour of the butter (Kashaninejad et al., 2016).

Flavour and aroma

The aroma of butter depends largely on the type of cream used for its production and its composition is directly related to the type of milk and the production process (Mallia et al., 2008). To date, more than 200 volatile compounds have been identified in butter, but only a small number of them are considered to be carriers of aroma (Mallia et al., 2008). Butter obtained by processing sweet cream contains mainly aromatic components from the group of lactones (fruity and creamy notes) and sulphur compounds. Butter obtained from fermented cream, on the other hand, is rich in compounds such as diacetyl, butyric acid and δ-decalactone, which are produced during fermentation by the action of lactic acid bacteria and lead to more intense, acidic flavours (Mallia et al., 2008). In addition to fermentation, the flavour of butter is also influenced by the animals' diet, the type of milk, the lactation period, the production process and the storage conditions (Mallia et al., 2008). During the production process, fatty acids released by the hydrolysis of triacylglycerides, especially short-chain fatty acids, play a key role in the formation of butter aroma. Cow's milk contains a higher proportion of medium- and long-chain saturated fatty acids, which give it a sweet and mild flavour, while sheep's and goat's milk contain more short-chain fatty acids such as caproic, capric and caprylic acids, which give the butter a more aromatic and piquant "goat flavour" (Lee, 2020).

Undesirable flavours can also develop in butter due to various factors, including lipolysis, fat oxidation, microbial activity and exposure to light (Mallia et al., 2008; Ceylan and Ozcan, 2020). Processing and storage conditions play an important role in the different flavour profiles of butter. Generally, butter made from pasteurised milk develops less flavour than butter made from raw milk due to the inactivation of enzymes and the loss of natural microbial flora found in raw milk. Consequently, pasteurisation can help to reduce off-flavours in butter products caused by lipolysis (Grappin and Beuvier, 1997). The oxidation of unsaturated fatty acids can produce hydroperoxides which, when interacting with other molecules, can cause a metallic or cardboardy flavour. Lipolysis, which takes place under the influence of lipoprotein lipases, can lead to the formation of free fatty acids, which can cause a bitter or soapy flavour depending on the source of the lipase. Exposure to light can cause photo-oxidation, resulting in a metallic or burnt flavour, while the photodegradation of methionine with the formation of methional leads to the formation of a mushroom flavour.

Texture

The texture of butter includes properties such as softness, plasticity and consistency, with firmness and spreadability being critical for both producers and consumers (Lis et al., 2021). These textural properties are influenced by factors such as the concentration, size, shape and distribution of fat crystals, fat globules, air bubbles and aqueous droplets (Buldo et al., 2013). As one of the most complex edible fats, butter contains over 400 fatty acids whose composition directly affects crystallisation and the resulting physical properties, including melting and solidification temperatures, which determine firmness and spreadability (Wright et al., 2001; Tang et al., 2007). The ideal texture of butter is smooth, slightly firm and plastic and resists cutting. This texture is determined by the size of the fat globules, the milk fat content and the fatty acid composition, which vary depending on the dairy animal and feed (Vioque-Amor et al., 2023). For example, cow's milk is richer in medium- and long-chain saturated fatty acids (palmitic acid, lauric acid, myristic acid), which makes it firmer (Pădureţ, 2021; Staniweski et al., 2021; Lapčiková et al., 2022), while goat's and sheep's milk butter has a softer texture due to the presence of more unsaturated (oleic acid) and short-chain fatty acids (capric, caproic and caprylic acid) (Lee, 2020). Hardness and spreadability are closely linked and are influenced by the fat content, the ratio of solid to liquid fat, the fat source and the temperature (Glibowski et al., 2008). In addition, the intensity of cooling during ripening affects fat crystallisation, with slower cooling leading to larger crystals and faster cooling leading to smaller crystals.

Pasteurisation of milk reduces spreadability compared to butter made from raw milk (Sert and Mercan, 2020). Temperature and duration of heat treatment influence the spreadability in such a way that the hardness decreases with increasing temperature and time (Rønholt, 2012). A higher proportion of solid fats reduces the lubricity, and the fat composition, especially the proportion of unsaturated fatty acids, correlates positively with the lubricity (Ceylan and Ozcan, 2020).

CONCLUSIONS

Different types of cream, whether sweet or sour, bring specific aromas and texture to the butter, and the choice of ripening process depends on the composition of the milk, which changes depending on various factors such as the season and the feeding of the milking animals. Cream ripening is a key process in the production of butter and is responsible for the formation of its sensory properties, including flavour, aroma, texture and colour. These characteristics are directly related to the type of milk and cream used and the technological processes, while controlled storage conditions can significantly extend the durability and preserve the quality of the product. The colour of the butter varies depending on the amount of carotenoids in the milk, so cow's milk butter has a more intense yellow colour, while sheep's or goat's milk butter can be almost white. The flavour and aroma of butter significantly depend on the type of cream; in sweet cream butter, fruity aromas are formed, while the use of sour cream results in stronger, more acidic aromas. Therefore, a careful approach in the entire process of butter production is of essential importance for achieving the desired characteristics, preserving the quality of the product and satisfying the end users. This complexity in the production of butter

makes it not only a food product, but also the subject of scientific research, innovation and improvement in food technology.

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Contact Information: Asst. Prof. Darija Bendelja Ljoljić, PhD, University of Zagreb Faculty of Agriculture, Division of Animal Science, Svetošimunska 25, 10 000 Zagreb, Croatia, e-mail: dbendelja@agr.hr