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TRADITIONAL AND INNOVATIVE AGING TECHNOLOGIES OF DISTILLED BEVERAGES: THE INFLUENCE ON THE QUALITY AND CONSUMER PREFERENCES OF AGED SPIRIT DRINKS

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Abstract: Aging is one of the most important processes in the production of high-quality spirits, including whisky, brandy and cognac. The contact between wood and distillates is a crucial step for the migration of chemical compounds, which evoke the novel sensory properties of the final products. Novel taste is pleasurable for a vast group of consumers and depends on cultural preferences. In order to demystify the main chemical compounds for aroma contribution, connecting them with a sensory profile of aged spirits is a crucial step in hastening the very timeless process without decreasing the quality. Consumption patterns of spirit drinks have been influenced by changed consumers' preferences and increased availability of different types of spirits on the market. Consumers' choice of one type of spirit drinks over others is significantly shaped by extrinsic attributes and consumer-based factors, but the choice among different available options of the single type of spirit may be based on consumers' perception of its specific sensory attributes. Therefore, the combination of taste, aroma, color and other sensory attributes of a spirit drink can shape consumers' perceived quality of the spirit and impact the potential of its market success in general.

Key words: aging, distilled beverages, wood cask, cognac, whisky, brandy, sensory attributes, consumer preferences, perceived quality.

Introduction

The alcoholic beverages industry is one of the most important food sectors with constantly growing interest of the industrial as well as scientific society (Babor, 2009). One potential reason for that is the fact that the global alcoholic

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beverage market was estimated at almost 1.5 trillion dollars in 2018 (Statista, 2020). Another reason is that the global alcoholic beverage market also grows annually by 7.7%, which is driven by multiple factors, such as consumer preferences, changing lifestyles, and expansion on the untraditional markets, such as China (Statista, 2020). Additionally, modern research has confirmed that moderate consumption of alcohol enriched with phenolic compounds has multiple positive effects on consumer health (e.g. reduction of the risks of coronary heart disease, certain cancer types, stroke, the elimination of *Helicobacter pylori*, etc.) (Dasgupta and Klein, 2014; Veljović, 2016).

Given the diverse nature of alcoholic beverages, they can be classified into three general groups: beer, spirit drinks, and wine (Dasgupta and Klein, 2014). Spirits are alcoholic beverages with a minimum alcoholic strength by a volume of 15% (EU Commision, 2019). The production of spirits generally includes the fermentation of various agricultural products containing carbohydrates, a distillation of fermented mixture, aging, and blending (Awad et al., 2017). Besides aromatic compounds originating from raw materials, compounds composed during the aging process are important contributors to overall sensory quality, authenticity, and uniqueness of spirit drinks (Conner et al., 2003; Pecić et al., 2012b; Pecić, 2015; Śliwińska et al., 2015; Wiśniewska et al., 2016; Canas, 2017; Veljović et al., 2019a).

Alcoholic beverages have been consumed since ancient times, and their consumption represents a common segment of social gatherings, as well as the culture of eating (Maharjan, 2019). Preferences of alcohol beverages and patterns of alcohol consumption are largely influenced by cultural and social norms, as well as the traditions of different countries (Song et al., 2018; Podstawski et al., 2019; Veljović et al., 2019b; Zasimova and Kolosnitsyna, 2020). In European culture, the consumption of alcoholic beverages is considered to be socially acceptable in many contexts and has an important role in a diet (Cravero et al., 2020). There are differences in Western and Eastern patterns of consumption. For example, in the Western culture, three categories of consumption of alcoholic beverages exist: aperitifs or pre-meal drinks, mid-meal drinks, and digestive or after-meal drinks, while in the Chinese culture, alcoholic beverages are only consumed during meals (Song et al., 2018).

This manuscript deals with the world's most important aged distilled spirits – whisky, cognac, and brandy. The production steps of these spirits are very similar, and most producers maintain that cask maturation and blending make a crucial contribution to the final character as well as sensory profiles of these aged spirits (Wiśniewska et al., 2016; Winstel and Marchal, 2019; Smailagić al., 2021). Consequently, the main focus is put on traditional and modern aging technology and its influence on sensory quality as well as consumers' preferences.

Overview of selected aged spirits

Whisky

Whisky (or whiskey) is a distilled spirit drink produced in many parts of the world (Buglass et al., 2011). According to historical data, Ireland is the country of whisky origin, while the first published data about whisky distilling was found in the Annals of Clonmacnoise dated from the year of 1405. The necessary skills for whisky distillation were brought to Scotland by missionary monks, and the earliest record of whisky production in this country dates from 1494 (Power et al., 2020). From the United Kingdom and Ireland, distillation practice expanded to countries that have been largely influenced by European emigrants, such as Canada, India and Japan. Nowadays, the United States, Canada and Japan are included among major producers (Power et al., 2020). Although the whisky technology expanded to other countries, Irish and Scotch whiskies still remain the two most valued European, as well as world whiskies, with globally recognized geographical indication.

Whisky is also an economically important spirit drink with a projected revenue of more than 87 billion in 2020, with the highest rate in India (with 19.2%) (Statista, 2020). In order to protect and standardize the quality of the whisky, basic requirements are defined by the Council Regulation (EEC) No. 2019/787 of the European Union (EU) (EU Commission, 2019). Thus, whisky is produced by distillation of a mash made from malted cereals, with or without whole grains of unmalted cereals, fermented by the action of yeast (*Saccharomyces cervisiae*); and every distillation is carried out at less than 94.8% vol. Furthermore, the distillate has an aroma and taste typical for utilized raw materials. Aging of the final distillate is limited to at least three years in wooden casks not exceeding 700-liter capacity. However, the common commercial practice is that aging is much longer, sometimes even longer than 12 years (Roullier-Gall et al., 2020). Particularly for high-quality whisky, aging in a cask is longer than five years. Generally, the period from 15 to 21 years is considered to be the optimal period for aging malt whiskies, but, from the quality point of view, the longer period can be detrimental to overall quality (Buglass et al., 2011).

Brandy

Considering the brandy market at the global level, this broad segment, regulated by Food and Drug Administration (FDA) in the USA, includes spirit drinks produced from very different raw materials, such as wine, grapes or different fruits (e-CFR, 2021). Namely, the selection of raw materials depends on local character, cost price, and availability. Consequently, due to all differences

among them, there are no unique legal definitions of brandies. As well as whisky, the brandy market is generally profitable, and the projected revenue of this alcoholic beverage segment amounts to more than 60 billion dollars in 2020. In global comparison, most revenue is generated in the United States (22.7%) (Statista, 2020).

Under EEC 2019/787 (EU Commission, 2019), brandy (*Weinbrand* in German-speaking countries) is defined as a spirit drink produced by wine distillation at less than 94.8% vol. alcoholic strength. According to the regulation, a fresh distillate is required to mature in oak casks. Depending on cask capacity, the maturation time of brandy must be at least one year in oak casks or for at least six months in oak casks with a capacity of fewer than 1000 liters. The minimum alcoholic strength by volume of brandy is limited to 36%.

According to EEC 2019/787, fruit spirits, pomace spirits, and even grape brandy are not included under the term brandy. European countries have a long tradition in the production of fruit spirits, often known as fruit brandies. According to EEC 2019/787 (EU Commission, 2019), fruit spirits are defined as alcoholic beverages produced by the distillation of fermented fresh fruits or their must, with or without stones. The used type of fruits depends on the production tradition and the region of origin. Although maturation is not strictly required for fruit spirits, local fruit spirits are traditionally aged in wood casks for many years. Unlike whisky, the type of casks and the duration of maturation are not defined according to the international or local regulation for fruit spirits (Mosedale and Puech, 1998; Canas, 2017). Moreover, an ingrained belief is that the quality of aged spirit increases with the pronged aging period in wood casks, lasting even more than a few decades.

Differently from EU regulation, U.S. legislation defined fruit brandies as an alcoholic distillate from the fermented juice, mash, or wine of fruit or the residue thereof (e-CFR, 2021). Additionally, if the brandy has been stored in oak containers for less than two years, it must be labeled as immature.

Cognac

Among aged wine spirits, especially notable is a type known as cognac, produced in the Charentes region, nearly all of Charente Maritime, and some neighboring communities in Southwest France (Ferrari et al., 2004; Lurton et al., 2012). The production of cognac dates back to the 16th century and with the strictly regulated process (Canas, 2017). Thus, cognac is produced by twice distilling white wines produced in designated growing regions, also known as the Cognac region. After the distillation and during the aging process, the product is also called *eau de vie*, which means “a water of life” (Buglass et al., 2011).

As previously mentioned, for brandy, the wine spirit must be aged for at least one year or six months (Wiśniewska et al., 2016). However, cognac is a wine spirit with geographical indications, so the aging period lasts for at least two years. The importance of the cognac aging period is officially recognized under "Product specification for the cognac or *eau-de-vie* de cognac or *eau-de-vie* des Charentes controlled appellation of origin, and designations" based on the length of aging of the youngest eau-de-vie in the blend" (Official Journal of the French Republic, 2018). According to this decision, different official labels of cognac are defined due to different years of aging, as summarized in Table 1.

Table 1. The minimum age of cognac wine spirits.

Term	The star numbers	The aging years*
3 Etoiles, Sélection, VS, De Luxe, Very Special and Millésime	Compte 2	at least 2-year aging
Supérieur, Cuvée Supérieure and Qualité Supérieure	Compte 3	at least 3-year aging
V.S.O.P., Réserve, Vieux, Rare, Royal and Very Superior Old Pale	Compte 4	at least 4-year aging
Vieille Réserve, Réserve Rare, and Réserve Royale	Compte 5	at least 5-year aging
Napoléon, Très Vieille Réserve, Très Vieux, Héritage, Très Rare, Excellence, and Suprême	Compte 6	at least 6-year aging
XO, Hors d'âge, Extra, Ancestral, Ancêtre, Or, Gold, Impérial, Extra Old, XXO, and Extra Extra Old	Compte 10	at least 10-year aging starting
XXO, and Extra Extra Old	-	wine spirits that have been aged for at least 14 years.

*starting from 1 April, the year after the harvest.

Aging process

Wood packaging has been used in winemaking since pre-Christian times (Le Floch et al., 2015). In almost the same design since the Celts, wood casks have been used as the most reputable packing material for exclusive alcoholic beverages (Viriot et al., 1993; Zhang et al., 2015). Since distillation practice had not been common knowledge until the 15th century, the wood casks were first used exclusively as wooden containers for wine. After the commercialization of distillation, wood cask utilization for distillate aging became standard practice. Generally, in the early days of cask aging, the quality of cask was not of particular interest, so producers used any available cask (Buglass et al., 2011). During the centuries, the purpose of cask expanded beyond storing, so producers and consumers have come to recognize multiple benefits of aging in a wooden cask and its impact on the quality of the final spirit, mainly on sensory attributes.

The importance of the cooperage industry is proven by the value of global export, which is estimated at more than one billion dollars in 2020 (TradeMap,

2020). Furthermore, France and the United States were the dominant exporters with 51.2% and 23.1% of the total value, respectively. These data are expected since the main regions of famous oaks for cooperage have traditionally been France and the USA (Mosedale and Puech, 2003). According to TradeMap data (TradeMap, 2020), in 2020, the most dominant global importers of wood casks, which are used for aging of whisky, cognac and brandy, were the United States, the United Kingdom, France and Ireland.

Generally, the aging process has been highlighted as a critical step for producing high-quality spirits (Canas, 2017). From a legal point of view, the most prominent aged alcoholic beverages within the EU are protected from counterfeit and fraud by definitions and statements within the EEC 2019/787 (EU Commission, 2019). Thus, the basic requirement for the majority of famous aged spirits is strictly defined by law, with the main focus on the minimum aging time as well as the cask type. Furthermore, under protection by geographic origin (e.g. whisky, cognac, etc.), the regulation additionally defines the origin and quality of materials used for cask production. In many regions, the aging process also broadly refers to "traditional practices" experience and know-how that local professionals have developed over many years. This knowledge is transmitted traditionally by generations and represents a part of the specific cultural identity and cultural heritage of the regions. The geographic origin also represents an important factor of brand identity and market differentiation (Kostić-Stanković and Cvijović, 2017).

Different types of wood are used in cask production, and the selection mostly depends on the local tradition. Taking into account the differences among wood species, oaks are the most often utilized for cask production due to unquestionable superior mechanic, physical and chemical properties (Viriot et al., 1993; Smailagić et al., 2019). Out of 250 species of the genus Quercus, the following types of the oak tree, *Quercus petraea* L. (*Q. sessiliflora*) — the sessile Oak and *Quercus pedunculata* (*Q. robur*) — the pedunculate Oak in Europe, and *Quercus alba* in North America, are mostly used.

Cognac is a spirit with geographical indication, thus wooden casks are produced from particular types of oak: fine-grained Tronçais or coarser-grained Limousin, *Quercus petraea* (sessile oak) or *Quercus robur* (pedunculate oak) (Official Journal of the French Republic, 2018). Depending on the country of origin, different wooden casks are used for whisky aging. In the USA, the whisky must be aged in new, charred casks produced from white oak (Qian et al., 2019). In Scotland, reused casks used for whisky aging are of either American oak (Bourbon casks), European oak (usually Sherry casks) or rejuvenated oak (Halliday, 2004). Differently from cognac and whisky, brandy can be aged in cask produced from local oaks as well as alternative wood species (e.g. mulberry, black locust, white ash, plum, cherry, elm, etc.).

As global demand for wood casks is constantly increasing, woodcutting of all old trees (e.g. oaks are older than hundred years) have a negative effect on the environment and also threaten the future of the cooperage industry due to the non-availability and high cost of oak timbers (Smailagić et al., 2019). Thus, the International Organization of Vine and Wine (OIV) approved the use of wood fragments, including wood staves, chips or sticks, to hasten the spirits aging process (Coldea et al., 2020; Smailagić et al., 2021). Evermore, another novel trend is the utilization of alternative wood species from the local region, such as Eastern Europe.

Due to the significant time and cost differences inherent between aging in casks and with alternative methods, the final aged spirit drinks must have similar sensory attributes, mainly pleasurable and common for consumers.

Sensory analyses of aged spirits

Aged spirits are a complex alcohol-water mixture with great complexity and numerous ingredients, with the concentration that varies within an average of 0.001–1.0% (v/v). The determination of aged spirit quality is a complex problem. Besides its chemical composition, the sensory profile is generally the most important parameter for high-quality spirits, whereas aromatic compounds are the main constituent of their sensory profile. Even more, their contents, odor attributes, and thresholds are primary factors that affect the sensory quality of all alcoholic spirits, including aged spirits. Aromatic compounds can be classified into four groups: primary, secondary, tertiary and quaternary (Tešević et al., 2005; Pecić et al., 2011; Canas, 2017). The primary compounds originate from the raw material, concentrated in the inner layer of fruit skin, while grain and agricultural materials are not a rich source of aromatic compounds. In the fermentation process, the distillation and aging processes form, evoke or concentrate secondary, tertiary and quaternary aromatic compounds, respectively. All production steps have an influence on the sensory characteristics of the product, but, in standardized industrial production, the aging parameters (the maturation time and the kind of wood cask) are the main factor that defines uniqueness and its most valuable specifications.

After distillation, fresh distillates are often characterized by raw, pungent odor and taste, and consequently, they are not appropriate for consumption (Christoph and Bauer-Christoph, 2007; Pecić et al., 2012a). Thus, the fresh distillate must be aged in a wooden cask in order to create the characteristic sensory attributes (Pecić, 2015; Veljović et al., 2014). During the aging in wooden casks, the hundreds of volatile compounds derived from the wooden cask contribute to the aroma of the spirit during the aging process (Caldeira et al., 2006a). Taking into account the complexity of the aged spirit, generally, it can be pointed out that only a few compounds have the key influence on sensory perception (Pecić et al., 2016;

Tsakiris et al., 2014). Main volatile aroma compounds originated from the toasted wood include cis-*β*-methyl-*γ*-octalactone and trans-*β*-methyl-*γ*-octalactone ("whisky lactone"), vanillin, guajacol, eugenol, cresols, and other phenolic compounds. These compounds contribute to oak wood and vanilla-like flavor. A recent study has found that quercotriterpenosides, natural sweet compounds extracted from oak wood during aging soften the aroma of fresh distillates (Marchal et al., 2011; Marchal, et al., 2015). Besides the influence on overall sensory quality, the presence of particular chemical compounds, such as scopuletin, is considered as a proof of maturation in oak casks (Tsakiris et al., 2014). From a chemical point of view, the volatile compound profile of aged spirits (e.g. cognac and whisky) is almost the same qualitatively, but quantitatively, it is significantly different (Ferrari et al., 2004).

Besides the difference in the origin of wood material, Granja-Soares et al. (2020) have found that the innovative aging process undoubtedly has a greater influence on wine spirit quality than the type of wood. On the other hand, the sensory characteristics of developed aged spirits must be acceptable for sensory evaluators as well as consumers. The sensory evaluators mark the analyzed samples from a qualitative or/and quantitative point of view. For qualitative evaluation, the sensory experts describe carefully selected descriptors based on the sensory characteristics of particular spirits. The main sensory descriptors for aged spirits are woody/smoky, vanilla, toasty, caramel and spicy (Buglass et al., 2011).

Despite the extensive use of wood fragments, the regulation of the quality, labeling, and technical process has still not been considered on local or higher levels. Spirits with protected geographic designation have strict regulations, and alternative aging methods are forbidden (Schwarz et al., 2020). However, as previously mentioned, multiple factors have a strong influence on the increased utilization of alternative aging methods in the alcoholic beverage industry. Thus, recent scientific studies open the novel fields, having a strong connection between practical experience and the optimization of these processes in order to develop aged spirits of the same or ever-higher quality. In due course, it is possible that alternative aging methods may become accepted and, after a further time, become traditional, like cask aging. After all, consumers will give the final judgment of developed products, but cheaper products will represent an important market advantage and a more financially attractive business.

Attributes that influence the consumption of spirits

Multiple factors influence the multisensory perception of flavor and overall positive attitudes towards spirits. These factors are generally divided into two groups – intrinsic and extrinsic. Intrinsic factors include internal traits of the spirit itself, like taste, aroma, color, mouthfeel and aftertaste, while extrinsic factors are related to packaging, brand name, label, price, origin, marketing activities or

external environment (Lee et al., 2000; Wang et al., 2019a). Both groups of factors have their impact on beverage liking and consumption. The type of alcoholic spirits preferred for consumption may also depend on situational variables (Calvo-Porral and Levy-Mangin, 2019; Pierguidi et al., 2019; Pierguidi et al., 2020), as well as psychological factors (consumers' personality traits), prior experience and expectations (Lee et al., 2000) and individual differences in taste responsiveness (Pierguidi et al., 2019; Pierguidi et al., 2020). The influence of these factors is presented in Figure 1.

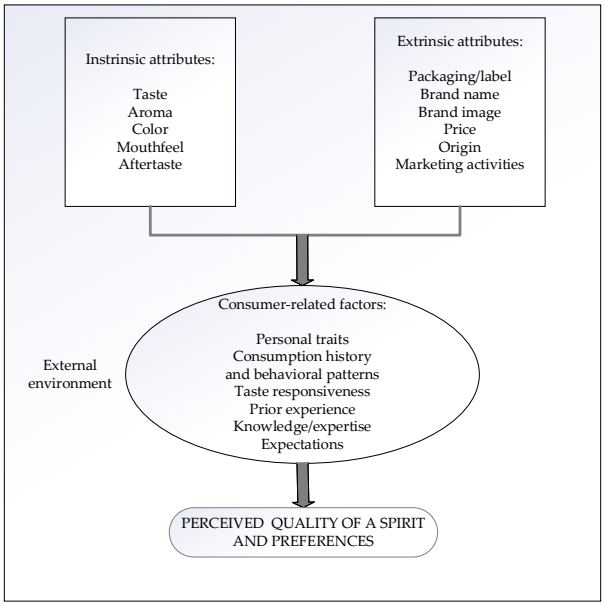

Figure 1. Groups of factors that influence consumers' preferences for alcoholic spirits.

Besides consumer-related factors, preferences of spirits are also stimulated by specific attributes of a beverage. Attributes related to taste and smell are most often taken into consideration when examining consumer preferences towards beverages (Rajić et al., 2018). In other words, the consumption of certain beverages is driven by the sensations it provides (Fiches et al., 2016). Among different consumer expectations, satisfying sensory quality is considered the key success factor for the appreciation of a product (Fiches et al., 2016). For such reason, it is necessary to analyze make an analysis of consumers' perceptions of certain sensory attributes and preferences towards alcoholic spirits (Glenk et al., 2012). Changing certain sensory attributes may result in the changed perception, and thus, the overall evaluation of a product. For example, varying the scent or color of beverages can

influence the perception of their aroma. There is empirical evidence of a link between sensory properties and emotions, namely, sensory attributes act as sensory drivers of emotions, consequently leading to product (dis)liking and positive or negative affective attitudes (Spinelli and Jaeger, 2019). By obtaining data through sensory perception during the consumption of an alcoholic spirit, consumers use pattern recognition processes, which means using sensory data to constitute a holistic mental image in specific regions of the brain. As a result, they produce a flavor recognition based not only on sensory data obtained at the time of consumption but also information from long-term, short-term and sensory memory systems (Lee, 2000). This will provide valuable input for the development of novel spirits which should contain desirable sensory attributes. The identification of sensory attributes that can deliver a notion of perceived taste and drive liking of a product is important for producers in terms of developing novel products that will have greater potential to stimulate consumer satisfaction (Farah et al., 2017; Wang et al., 2019b). It will enable greater market segmentation, optimization of manufacturing processes (Cravero et al., 2020), marketing strategies for new products, reformulation of existing ones, and formulation of quality control programs (Farah et al., 2017). For such reasons, research of consumers' preferences, and the identification of key sensory attributes based on the olfactory and gustatory impression, are prerequisites for a novel product launching (Rozin and Hormes, 2010). Identifying the most significant drivers of consumption enables a better predictability of consumer behavior in different markets, which, additionally, enlarges the potential for further market expansion (Veljović and Krstić, 2020).

Sensory marketing of spirits and its impact on consumers' perception and preferences

Consumers' individual experience during eating and drinking is based on various sensations, including taste, smell and touch (Rozin and Hormes, 2010; Redondo et al., 2014). As Bachmanov et al. (2003) noted, taste, olfaction, and chemosensory irritation are three independent sensory systems that enable the perception of flavor. Anetoh et al. (2020) noted that visual, gustatory, tactile, and olfactory attributes of beverages significantly influence the purchase intentions of consumers. "In addition to its composition, the overall perceived flavor of a food is mainly impacted by the way in which volatile aroma compounds are released in the mouth and transported to the olfactory receptors in the nose during food consumption" (Déléris et al., 2011). As a result, consumer preferences significantly depend on the sensory attributes of food and drinks and flavor perception (Le Berre et al., 2007; Holt et al., 2008).

Considering the importance of sensory attributes in driving consumption, the concept of sensory marketing has been developed and implemented. Sensory marketing has gained great importance as an effective marketing approach to influence consumers (Haase and Wiedmann, 2018). It is based on creating appeals that are able to stimulate visual, olfactory, haptic, auditory, and gustatory sensory systems in a better way than is the case with traditional marketing. The incorporation of such stimuli in marketing and sales programs is often done in the food industry (Vukmirović et al., 2018). Sensory marketing has proven to be especially influential for various experiential products such as beverages (Biswas et al., 2010; Kellershohn, 2018). Krishna (2012) defined sensory marketing as "marketing that engages the consumers' senses and affects their perception, judgment and behavior". Hultén (2015) has noted that the effectiveness of sensory marketing lies in its potential to affect consumption activities, so sensory marketing is based on using implicit marketing appeals that stimulate subconscious triggers that characterize consumers' perceptions of abstract notions of products, such as their quality and sophistication. By triggering customer senses, it represents an effective way to stimulate consumers to purchase/consume products that evoke certain sensations (Krishna, 2012). In order to develop proper sensory marketing activities and appeals, as well as to evaluate the obtained results, it is necessary first to assess consumers' perception of sensory cues of a certain alcoholic spirit. In the literature, there are various scales developed for this purpose. For example, Haase and Wiedmann (2018) developed a holistic scale for the measurement of the sensory perception of consumers. As stated by Cangussu et al. (2020), "sensory analysis objectively characterizes foods and beverages through the analysis of information perceived by the human senses". In the process of the sensory evaluation process, "blind-tastings" of consumers and experts are commonly used, which aim to enable participants to express their perception of taste and preferences based on intrinsic attributes and prior experience (Lawless and Heymann, 2010; Wang et al., 2019a). Perceived taste and liking are individually shaped, and they depend on the perceived intensity of taste and flavor (Samant et al., 2017). Generally, such marketing strategies are created to promote the intrinsic properties of the spirit more than emphasizing extrinsic attributes such as brands and labels (Maharjan, 2019). As sensory marketing has been developed, it goes beyond the traditional five sensory systems and their influence on product evaluations. For example, Biswas et al. (2019) extended the concept of sensory marketing by studying the effects of the vestibular system (responsible for balance and posture) on taste perceptions. They concluded that when eating/drinking in a standing (contrary to sitting) posture, consumers evaluate the taste of foods and beverages as less pleasant.

Sensory analysis may be based on employing different methods such as discrimination testing if the goal is to determine whether the product differs from

other product(s), and to perform descriptive analysis in order to determine the way it differs regarding specific sensory attributes; or sorting or projective mapping if the goal is to determine the way certain product differs from competitors holistically without reconsidering differences in specific sensory attributes. The nine-point hedonic scale ranging from extreme liking to extreme disliking is used most commonly for this purpose. Consumer testing is preferably conducted as blind testing, so the focus is put on the effects of intrinsic attributes (color, odor, taste, mouthfeel, and aftertaste) on product liking and consumers' choice so that they can are observed isolated from the effects that extrinsic attributes would have (if the price, the label, the origin would be indicated) (Heymann and Ebeler, 2016).

Sensory attributes of alcoholic spirits and their impact on consumers' preferences

There is empirical evidence that sensory characteristics drive consumer preferences of spirits and can be used for differentiation in relation to the competition. Raz et al. (2008) examined the influence of four groups of factors: color intensity, flavoring, label type and pack size, and found out that color intensity and flavoring, which represent intrinsic factors, are the main drivers of consumer preferences, while other two, which represent extrinsic factors, have a lesser effect on consumers' preferences. In their research, Monteiro et al. (2017) have found out that consumer evaluations of beverages are driven by aroma strength, color intensity and balance between sweetness and acidity. For alcoholic beverages, the aroma is found to significantly contribute to chemosensory perception and appreciation, so the quality of these beverages is to a large extent linked to aromatic richness and complexity (Le Berre et al., 2007; Holt et al., 2008; Fiches et al., 2014). Flavor plays an important role in accepting or rejecting alcoholic spirits (Bachmanov et al., 2003). Because of that, so-called flavor wheels have become popular means to illustrate the flavors that are likely to be perceived when drinking spirits like whisky or brandy, which are used for the purpose of training sensory assessors or communicating with marketing and sales departments and consumers (Lee et al., 2001; Piggott and Macleod, 2010). Spence and Wan (2015) found out that sensory qualities of the spirit can be enhanced by other factors, one of which is the shape of the glass. A glass that consumers find to be proper can enhance their perception of the sensory and hedonistic qualities of the spirit.

Cravero et al. (2020) determined three groups of customers in relation to their preferences of beverages based on investigating the individual responsiveness to various oral sensations that alcoholic and non-alcoholic beverages provoke. These groups are: "spirit-lovers" – the smallest group, mainly consisting of male consumers, aged 30–45, who enjoy consuming alcoholic beverages of any kind,

especially spirits, more than other segments; "beer/wine lovers" – the group that consists of older consumers of both genders; "mild-drink lovers" – the group that includes mainly women, aged 18–29, who demonstrate a lower consumption of alcohol but like alcoholic drinks with an intensely sweet taste and/or mixers that moderate the perception of ethanol.

Ethanol is considered to be the defining component of all alcoholic beverages, which, due to its physiochemical properties, has a tremendous influence on flavor perception and chemosensory evaluation of beverages, including distilled spirits. There is plenty of empirical evidence that changes in ethanol concentration can have an impact on alcoholic beverage flavor perception in terms of taste, aroma and mouthfeel (Le Berre et al., 2007; Boothroyd et al., 2012; King et al., 2013; King and Heymann, 2014; Ickes and Cadwallader, 2017; Ramsey et al., 2018). It has been shown that the dilution of whiskies to 23% ABV for "nosing" in the presence of long-chain ethyl esters is likely to change aroma perception (Boothroyd et al., 2012). When examining the role of ethanol in the aroma of whisky, Poisson and Schieberle (2008) emphasized the "masking effect" of ethanol, especially regarding fruity aroma, since an aroma model with a lower level of ethanol demonstrated a more expressed fruitier note as the complete model.

Distilled spirits, such as whiskies and brandies, are valued by consumers for the richness of their aroma and changes during product consumption (Glenk et al., 2012). Because of that, the aroma and flavor of whisky, cognac and other distilled spirits are critical factors of consumer acceptance, and therefore, must be regularly evaluated and controlled by conducting sensory analysis (Piggott and Macleod, 2010). As Poisson and Schieberle (2008) noted, whisky's characteristic is a unique aroma based on a combination of smoky, malty odors with a characteristic sweet, vanilla-based flavor note. Lee et al. (2000) defined a set of 16 compounds of whisky flavor standard (namely: acetic acid (sour), diacetyl (buttery), dimethyl trisulphide (sulphury), ethyl hexanoate (fruity-appley), ethyl laurate (soapy), furfural (grainy), geraniol (floral), guaiacol (smoky), hexanal (grassy), iso-amyl acetate (fruity-banana), iso-valeric acid (sweaty), maltol (sweet), phenyl ethanol (floral), vanillin (vanilla), 4-vinyl guaiacol (spicy) and whisky lactone (coconut)) that were recognized by 90% of assessors in their analysis. However, some authors pointed out the important influence of extrinsic attributes on the evaluation of the overall quality of the whisky, which means that the perception of whisky quality, as a result of the synergistic and holistic perceptual process, is "more than the sum of its component perceptions" (Wang et al., 2019a). Piggott et al. (1990) emphasized that differences in consumer perceptions of flavors of different types of whisky may be a result of perceptions of non-sensory attributes. According to their research findings, malt whisky was made clearly distinctive in relation to standard and deluxe blended whiskies and clustered together with brandy and liqueurs by female consumers. Authors noted that, in the case of female consumers,

who generally consume whisky significantly less than male consumers and possess little knowledge of the product, the appreciation of the finer whiskies is possibly developed primarily based on their image and not on intrinsic attributes.

Maharjan (2019) noted that brandy is a wide spirit category that includes a large number of different types of spirits, so it is necessary to explore what drives consumers' preferences and choices of certain types of brandy. The study of Fiches et al. (2014) emphasized the impact of aroma perception on the global sensory image of brandies. They concluded that differences in perception of different French grape brandies appeared to be based on differences in their volatile composition, which depends on aroma formation and steps in manufacturing processes, like fermentation and distillation. Fiches et al. (2016) studied the origin of temporal perception during the consumption of five brandies with different aging and qualities by applying sensory analysis. The results of the temporal sensory analysis demonstrated common perception sequences for all brandies related to taste and trigeminal sensations, while different aromatic sequences were emphasized between products, based mainly on their aging. Similar release patterns were noted in all cases, even though higher intensities were determined for esters in aged brandies, as they were present at higher levels. Additionally, the overall perception of brandies could be influenced by aroma compounds from wood which interacts with other perceptions. The impact of certain compounds of brandy flavor on the perceived quality was also confirmed in the literature. The compounds like toasted, woody, vanilla, body, flavor persistence and spicy were found to be significantly correlated with brandy quality, while the tails, green and caoutchouc (rubber) characters appeared to be negatively correlated with brandy quality. Also, the complexity of brandy flavor appeared to have a highly significant influence on quality. There is a certain flavor evolution that happens in brandy over the period of five years of maturation, so the intensity of aroma notes such as vanilla, woody, caramel, toasted, and smoke increases over time and may reach equilibrium after four years of maturation (Caldeira et al., 2006b). Louw and Lambrechts (2012) pointed to the empirical evidence that the majority of sensory modifications of brandies occur during the first three years of maturation in wood. Caldeira et al. (2006b) have concluded that the flavor complexity of brandies consistently increases for the period of at least the first five years of maturation in new oak barrels. On the other hand, alcoholic and glue-like attributes show a decrease over time, while attributes like dried fruits, smooth, tails and caoutchouc/rubber may not be uninfluenced by the maturation process. The findings of Caldeira et al. (2010), who applied sensory analysis to evaluate the effects of chestnut and oak barrels on the sensory attributes of Portuguese brandies, indicate that smoky aroma stands out as an important attribute that contributes to the perception of brandy quality.

The research conducted by Song et al. (2018) had the goal to provide valuable information for the creation of marketing communication strategies for cognac

brands tailored for American and Chinese consumers, based on different perceptions of the importance of different attributes. They found out that, in the case of American consumers, marketing appeals should be focused on the sensation and hedonistic character of cognac, including its taste, luxury feature and informal social settings where it is most often consumed. On the other hand, Chinese customers value most the social utilitarian functions of cognac and appreciate cognac brand more if it is associated with European culture, elitist lifestyle and business occasions for consumption.

Conclusion

The aging process has been highlighted as a key step for producing high-quality spirit drinks. Although other methods for aging are frequently used in practice, the regulation of the quality, labeling, and technical process is still not considered on local or higher levels. Spirits with protected geographical indications have strict regulations, and alternative aging methods are forbidden. Multiple factors have a strong influence on the increased utilization of alternative aging methods in the alcohol beverage industry. Recently, scientific studies have opened novel fields, making a strong connection between practical experience and optimization of these processes in order to develop aged spirits of the same or even higher quality.

The consumption of alcoholic beverages derives from ancient times, and today, it represents a common element of many social occasions and the culture of eating. Consumers react to the organoleptic properties of alcoholic beverages with their senses, so the perception of sensory information leads to the overall evaluation of the quality of the spirit. Identifying the key sensory attributes that drive the liking of a spirit is valuable in the process of the development of novel products, as well as for creating effective marketing appeals that have the potential to attract customers and stimulate purchasing and consumption. The identification of sensory attributes of distilled spirits, like whiskies, brandies and cognac, famous for the richness of their aroma and flavor, represents a critical factor for understanding consumer preferences, and therefore, it must be regularly performed by applying sensory analysis.

Finally, consumers will give the final judgment of developed aged spirits, but cheaper products will represent an important market advantage and a more financially attractive business. In due course, it is possible that alternative aging methods may become accepted and, after a further time, become traditional, like cask aging.

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TRADICIONALNE I INOVATIVNE TEHNOLOGIJE SAZREVANJA DESTILATA: UTICAJ NA NJIHOV KVALITET I SKLONOST POTROŠAČA PREMA SAZREVANIM ALKOHOLNIM PIĆIMA

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R e z i m e

Sazrevanje je jedan od najvažnijih procesa proizvodnje visokokvalitetnih alkoholnih pića, uključujući viski, rakiju i konjak. Kontakt drveta i destilata je presudan korak za migraciju hemijskih jedinjenja koja evociraju nova senzorna svojstva konačnih proizvoda. Novi ukus je ugodan za vrlo široku grupu potrošača i zavisi od kulturološki uslovljenih preferencija. Da bi se demistifikovala glavna hemijska jedinjenja, koja doprinose aromi, njihovo povezivanje sa senzornim profilom alkoholnih pića, koja su starila u buradima je presudan korak za ubrzanje vrlo dugotrajnog procesa, bez smanjenja kvaliteta. Na obrasce konzumiranja alkoholnih pića uticali su promenjene sklonosti potrošača i povećana dostupnost različitih vrsta alkoholnih pića na tržištu. Izbor jedne vrste alkoholnih pića u odnosu na druge značajno je oblikovan spoljašnjim atributima pića i faktorima koji zavise od samih potrošača, ali izbor između različitih dostupnih opcija jedne vrste alkoholnog pića može se zasnivati na potrošačkoj percepciji njegovih specifičnih senzornih atributa. Stoga, kombinacija ukusa, arome, boje i drugih senzornih atributa alkoholnih pića može da oblikuje percipirani kvalitet od strane potrošača i generalno utiče na potencijal njihovog tržišnog uspeha.

Ključne reči: sazrevanje, destilati, drvena burad, konjak, viski, rakije, senzorni atributi, preferencije potrošača, percepirani kvalitet.

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