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Review Article

Interesting Approaches on the Quality in Sparkling Wines Around the World

Cláudia Alberici Stefenon[1,2]* and Camila de Martini Bonesi[2]

[1]MBA em Enogastronomia, União Educacional de Cascavel - Univel, Av. Tito Muffato, Cascavel, PR, Brazil

[2]Biotecsul - Tecnologia em Alimentos, Rua Gaston Luis Benetti, Caxias do Sul, RS, Brazil

***Corresponding Author**: Cláudia Alberici Stefenon, MBA em Enogastronomia, União Educacional de Cascavel - Univel, and Biotecsul - Tecnologia em Alimentos, Rua Gaston Luis Benetti, Caxias do Sul, RS, Brazil.

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Abstract

Sparkling wines have received increasing attention and are being the target of worldwide studies, due to the importance into the production chain of grape and wine in several countries. Furthermore, the moderate consume may contribute to bring benefits to human health. An intrinsic set of factors (physical-chemical composition, sensory profile and biological activities) is responsible for the modern concept of food and drink quality. Therefore, this paper aimed to build a review of these aspects, evaluating data already published internationally (including the Brazilian sparkling wines). Interdisciplinary knowledge from the chemistry, biochemistry, microbiology, engineering and nutrition are necessary for a greater understanding on the production dynamics in sparkling wines (especially regarding the chosen method). The oenological techniques that can be used vary depending on the wine origin, but even so, the results obtained are similar. Therefore, the data serve as reference for new research, aiming at the continuous advance in the elaboration of increasingly competitive products. Furthermore, the Brazilian sparkling wine can be ranked among the world's best, due to its sensorial characteristics and functional capabilities.

Keywords: *Health; Quality; Production Method; Sur Lie; Polyphenols and Yeast*

Introduction

Nowadays, the sparkling wines (SW) are produced in many countries. Besides the *Champagnes* (the *Crémants* – elaborated in some French regions and the *Vins Mousseux* -Charmat SW) [1], other products can be highlighted. According to Buxaderas; Lópes-Tamames [2], in Spain, the *Cavas* (Appellation d'origine contrôlée- AOC) of Cataluña are made by the Traditional Method with autochthones varieties Macabeo, Xarello and Parellada; in Germany, the Riesling is the queen white grape to make a *Sket*, due to their balanced acidity, fruit aroma and soft flavor; the Italian SW are known as *Spumanti* and have relation with the native varieties typical aromas and production areas. In the sense, *Franciacorta* (Denominação de Origem Controlada e Garantida – DOCG), *Trento* DOC, *Asti* DOCG (Moscato family grapes) and *Prosecco* DOC (Glera variety) have had great importance. In Brazil, the principal varieties to make a SW are Chardonnay, Riesling Itálico and Pinot Noir [3]. Serra Gaúcha is a traditional area responsible for the almost entire volume produced in the country and for the world status (exported to more 20 countries, as USA, Germany and England) is due to the overall great quality of their SW [4].

From a chemical view, SW can be considered as a complex hydro-alcoholic system in which the carbon dioxide (CO_2), formed during the second alcoholic fermentation, is dissolved in the medium. But in fact, the union between the facets of chemistry, microbiology and biochemistry form the product matrix complex [5].

The SW are rich in phenolic compounds [6,7] with renowned antioxidant activity [8,9]. However, the level of this compounds depends on many factors, as Terroir, grape variety and maturation grade, philosophy of the production, base wine quality, yeast and ageing on lees (*sur lie*), between others [7,10-13].

Many studies were already carried out to evaluate the antioxidant capacity of white and red wines [14,15]. Recently, the SW have been studied too [16-19], and is demonstrated that the phenolic composition is associated with the reduction on the cases of Atherosclerosis, Parkinson's, Alzheimer's and Cancer [20]. Furthermore, some minerals have had essential role to human's health [21,22], as K, Ca, Mg, are found into the wines [23]. These variables can change, direct or indirect, the sensory and biochemical characteristics (color, bitterness, aroma, flavor, longevity, antioxidant proprieties, …) as well, on the acceptation of the SW by the consumers around the world [24,25].

In view of the above, this article aims to construct an extensive discussion about the state of the art in SW, evaluating data already published internationally on the influence of the elaboration techniques on the physicochemical composition and the biological properties assigned to them, to contextualize the Brazilians SW in this scenario.

Discussion

Quality management and *Sur* Lie

The correct grape maturation due to vineyards improvement, as well as, the advanced-on winemaking technologies, are responsible for the increasing of Brazilian wine "Premium Quality" [26]. The management of variables determine the product overall quality (Figure 1) and, in the case of Brazilian SW, can be observed by the sale data a growth trend of 10% in the last years [4].

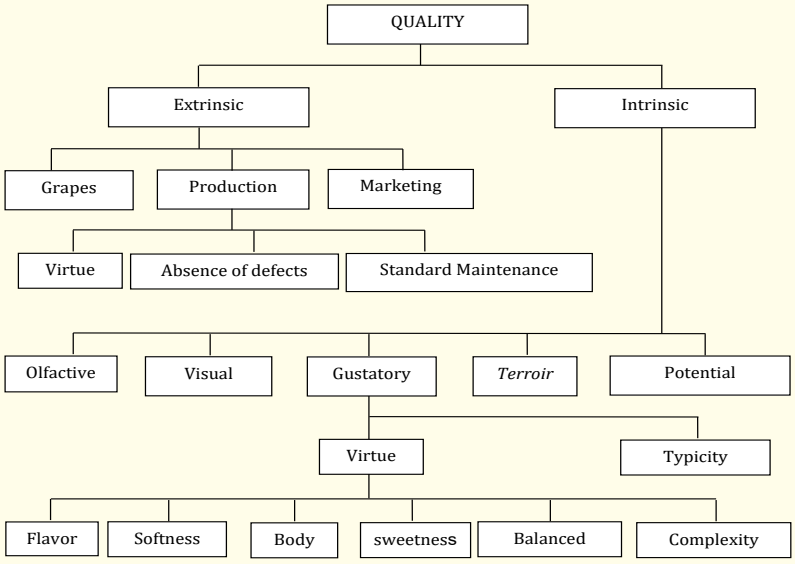

Figure 1: *Different parameters in the wine quality concept (Adapted from Charters; Pettigrew, 2007) [27].*

Viticulture, oenology and biotechnological processes are the main responsible for the analytical and sensorial differences that SW can present, which are linked to several factors that are part of the terroir and the methodology of elaboration. In addition to *perlage*, the formation of complex characteristics occurs mainly due to the maturation period, adsorption phenomena, synergism between the different phenolic groups, oxidation reduction processes, interactions between organic and inorganic compounds, enzymatic action, among others, as discussed above. This data can be an important tool, both technological and marketing [7].

According to Boulton [28], the SW production starts with the obtention of base wine. The grape is softly pressed to avoid the extraction/formation of undesirable compounds, as that generate the bitterness and the browning. The mosto is keep freshed to avoid the oxidation and the alcoholic fermentation can be carried out with a neutral character yeast with low formation of esters and sulfur deriva-

tives. The SW profile can be made by means of white base wines (*blanc de blancs*) or mixed with red and white base wines (*blanc de noirs*). The second fermentation (*prix de mousse*) occurs by the methods *Charmat* (big tanks) or Traditional (in bottle). Among many aspects of each method, the *sur lie* has more impact. In this sense, long periods of storage in a winery represents big costs, which means the quality control must be able to offer a stable product since the end of the production until the consumption.

According to Torresi., *et al*. [29] more than 60 genera and more than 500 species of yeasts have been described. Over the years, in-depth studies on the strains, have yielded microorganisms capable of withstanding the adverse conditions of the fermentative environment, especially in foaming. Therefore, the correct yeast choice to a particular product and the knowledge on sur lie need more considerations to obtain specific results in accord with on demand.

The *sur lie* has been more applied enological practice in the last years and, in some cases, is obligatory, as to *Champagnes e Cavas* [2,30]. The ageing on lees is conditioned by the product type (younger to oldest), thus, the principal reasons are of the sensorial nature. Wines more structured, with fullness and aromatic complexity, are made with longer periods of *sur lie* [29,30]. Although the base wine, the yeast lysis and the ageing on lees can be considered as a sensorial characteristics modulators, still remain some questions in relation to physical-chemical interactions between lees and wines [31,32]. Lees are constituted, in major part, by yeast cells of 5 mm, tartaric acid cristals and clarifie agents [2]. During the *sur lie*, many constituents are transfered, causing impact on stability and product profile [29], as example, expressive aroma [33], mouth sensations [34] and shelf life potential [35].

The yeast autolysis is represented by an enzymatic autodegradtion, initially of glucans in mannoproteins, that start on the end of alcoholic fermentation and is associated with the dead cells [2]. Moreover, lees contain a large variety of hydrolysis enzymes, such as proteases [36], responsible for the release of 85% of nitrogen and most of the peptides [37]. The hydrolysis of these compounds change due to the yeast strain [35], as well as on the temperature and duration of *sur lie* [29,38]. Membrane polysaccharides can also act as absorption agents, to obtained a better microbiological stability of SW [8,39].

Sensory characteristics and polyphenol roles

Several wine compounds, such as terpenes and polyphenols, are found in free form or conjugated with glucose molecules [40,41]. These compounds can be hydrolyzed by β-glycosidase enzymes, which have already been described in *Saccharomyces cerevisiae* [40]. The adducts formation between polyphenols and glucose can influence extremely important qualitative parameters, such as color, bitterness, softness, longevity, antioxidant activity, among others [42,43].

The modern concept of quality, in a competitive and global market, emphasize the consumer satisfaction; counteracting this trend means compromising the success of any product [44]. Therefore, the sensorial characterization has been used to define the oenological practices capable of evidencing sensorial differences between the different **terroirs** [45]. To minimize the differences between the methods and the taster's expertise, the use of statistical treatments is necessary, so that all aspects have the same weight in the final configuration of the evaluation [46]. Wine sensory analysis has as its main purpose to evaluate the sample within established standards, to translate the characteristics of a wine and show its identity to consumers [19]. Therefore, when evaluating wine, some aspects are highlighted, among them the intensity of aroma, flavors, body (structure), evolution, persistence, balance, typicality, aftertaste and possible defects [47].

Then, it is possible that the wine attributes are the reason for its consumption; SW are pleasant food products that provide pleasure to the consumer. In this sense, *perlage*, color and aroma are the three main factors that should be considered. Especially with regard to **perlage**, the four most relevant qualitative aspects are: foam formation, area of coverage, crown and bubble size [48,49].

According to Buxaderas; Lópes-Tamames [2], initially, the perlage is the union of bubbles (foam component unit) formed in the second fermentation. Each of the endogenous carbon dioxide bubble is wrapped in a film composed of surface-active substances which provide

viscosity, texture and durability to it. Then, the presence of surfactant molecules is preponderant to reduce the surface tension of the medium, allowing the bubbles to overcome the force that keeps them dissolved in the medium, favoring the formation of the foam crown. This process occurs due to the hydrophilic fractions (with polar affinity, therefore of easy dissolution in the hydro - alcoholic medium that is the wine) and hydrophobic (apolar - insoluble), that can be able to trap carbonic gas inside an interface, stabilizing the bubble. SW have several surface-active compounds, such as ethanol, glycerol, tartaric acid and fatty acids. Although ethanol is the most abundant, it is already known that the synergistic effect among the compounds is more important than its concentration. Therefore, other constituents of the wine also participate in the production of foam, being the more important: proteins, polysaccharides and polyphenols.

As described above, the foam production depends on the SW composition and this is derived from the base wine and oenological practices applied in its elaboration, the SW performance in the cup also depends on the temperature, as the bottle is opened, the way the liquid is served, the cleaning and drying of the cup, as well as the shape and crystal quality. These aspects requires the standardization of the service protocol, in order to have objective and consistent results [48].

The tonality of a SW depends largely on the varieties used in its production, being that the biosynthesis of the compounds responsible for the color occurs on *veraison* (color change) and is reinforced by the cluster's exposure to direct sunlight. It is important to remember that in wines obtained through white winemaking, hydroxycinnamic acids and flavonoids are the main groups related to this parameter [2]. The tonality differences are mainly due to the oxidation of these compounds, as this reaction intensifies the yellow color, which can become brownish in aged SW [6] due, for example, to the caffeic acid polymerization in orthoquinones [50].

The SW aromatic performance depends on the base wine constitution and the elaboration method used. The influence of the varietal aromas is especially important in the SW *Charmat* and, for those elaborated by the Traditional Method, the *sur lie* becomes preponderant [30]. Furthermore, many chemical and biochemical processes not yet fully understood involve the interactions between yeast and wine. They can cause sensorial changes, affecting the perceived quality and, therefore, the commercial value of the wine in question [29,38,45]. These issues have an essential role for the winemaker that aiming the balance of the sensorial properties [2,19].

Antioxidant Capacity

The identity, the SW general quality, and their functional characteristics are linked with the aspects mentioned above. Then, different authors studied the link between of the SW consumption and their probable health benefits, in function of the phenolic compounds present in these products [17,29,38].

Recent and innovative studies continue to demonstrate advances in mechanisms by which regular and moderate consumption of wine and sparkling wines can bring benefits to human health. Development of new blood vessels (angiogenesis), anticoagulant action (due to inhibition of thrombin), vasodilator effect (regulation of adenosine/endothelin, maintenance of pressure), anti-aging, neuroprotector, inductor apoptosis (cell death) and reducer of the risks involved in the triad heart/diabetes/obesity [51], are properties that can be cited.

These factors and studies on possible functional properties of foods and beverages are increasingly attracting the interest of the scientific community, industry and consumers in general, due to the search for pleasant products with proven food safety [42]. There are still few existing studies on the SW biological activity, and the concept "Wine and Health" (two words that encompass not only wines, but also juices, extracts, oils, etc.) need to be more clarified. Some works show: a) *Cavas* and Brazilian Charmat's SW (made with Chardonnay and Pinot Noir) was able to inhibiting the lipid peroxidation *in vitro* [52] and *in vivo* [42], b) *Champagnes* increased the concentration of vitamin E in the blood plasma [53], c) aqueous and organic extracts of *Champagnes* presented neuroprotective effect to oxidative stress [54], d) decreased inflammatory markers of atherosclerosis by *Cavas* [55], e) *Champagne* extracts were able to prevent damage caused by 5-S-cysteinyl-dopamine, substance involved in neurotoxicity associated with Parkinson's disease [56], f) polyphenols present in *Champagne* wine may induce cardioprotective (better vascular performance due the enhance nitric oxide bioavailability and the modulation of

metalloproteinase) and delaying the onset of degenerative disorders (increased spatial memory; [57]) and g) Portuguese SW DOC Bairrada and Brazilian SW made with several varieties showed important antioxidant capacity [16].

Recent studies on Brazilian SW have demonstrated the relationship between sensory characteristics, levels of phenolic compounds, enzymatic action (especially β-glucosidase) and antioxidant activity in products elaborated by Traditional and Charmat methods (samples explored was young, mature and aging on lees SW). The most important perceptions obtained in these studies, although not have determined the product quality level, were linked on the method of elaboration. The principal points were: a) long periods of *sur lie* bring more structure, deep flavors and aromatic complexity, while shorter periods represent freshness, elegance and delicate aromas, b) the *sur lie* proved to be one of the variables with the greatest impact, affecting the sequential reactions involved in the whole process, maybe by the difference in the volume of wine in contact with the lees (bottles or tanks), c) the studied phenolic compounds presented different curves for each method, as such as tyrosol and gallic acid, d) SW with chardonnay grape (only or in assemblage) had higher β-glucosidase activity than the other varieties evaluated (the cellular metabolism is triggered by enzymatic action, and these reactions form the matrix of the grapes and, therefore, the profile of the future wine), e) B-glucosidase activity remained stable during the *sur lie*. This is important to the balance between the reactions involving the glucose, resveratrol, piceid, caffeic acid and ferulic acid, acting on the antioxidant capacity and the general quality of the SW [7,9,18,19]. In other assay, we demonstrated that the antioxidant capacity (an important biological activity) is modulated by the maturation time on the lees, that is, the more mature was the SW, lower will be the performance against the oxidative stress. Therefore, the changes on the sensorial characteristics and on "wine and health" aspects, will be the choice for a short or long *sur lie* that will determine the specific characteristics of each SW (more than the choice of the method of elaboration) [38].

Finally, the studies conducted in different research centers use assays recognized and endorsed worldwide. The oenological techniques that can be used vary depending on the origin of the wine and SW, but even so, the results obtained are similar. These aspects enhance the importance of the data obtained, and these, serve as reference for new research, aiming at the continuous advance in the elaboration of increasingly competitive products. This way, we can suggest: 1. The choice of the varieties have directly influences on the profile of the final product, 2. The aging on lees modulates the physic-chemical composition found in different sparkling wines. 3. Modifications in phenolic composition alter the biological properties observed in studies conducted on a global scale, 4. The presence of glucose interferes in the final composition and decreases the antioxidant capacity, 5. To the tests used in the referred works above, the Brazilian SW had similar performance to the better sparkling wines in the world, as *Cavas* and *Champagnes*.

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