UNIVERSITY OF COPENHAGEN
FACULTY OF SCIENCE

Individual project report: Sparkling Wine and Bottle Fermentation

Carl-Henrik Brogren

Sparkling wine has for centuries been used to all kind of celebrations like war victories, sport competition, anniversaries, marriages, jubilees, sexual events, - but who discovered it? Louis XIV, Napoleon, Hitchcock, Marlene Dietrich, Winston Churchill, J.F. Kennedy, Marilyn Monroe and I have enjoyed sparkling wine with great pleasures both night and day.

University of Copenhagen, June 16th, 2017.

Master degree course on “Cool Climate Viticulture and Oenology”

PREFACE.

This overview of sparkling wine production will mainly focus on the so-called "method traditionelle" or "method champanoise", also known as bottle fermentation. Modern professional production of sparkling wine can also be produced in pressure stainless steel tanks, or even by carbonation of still wines. Fruit cider is often produced in one single fermentation step.

My personal knowledge concerning sparkling wines comes from preliminary experimentation with sparkling wine production from Solaris and Orion grapes harvested in the palace garden at the Bernstorff Castle in 2016, from our study tours to Reingau and Geisenheim University in May-June 2017, in particular visiting Andreas Muglers Kellerrie and from visiting the largest Crémant de Bordeaux producer, Lateyron, in the Montagne-Saint Emilion region in early June 2017.

The front-page picture shows a collection of sparkling wines produced by Andreas Mugler, e.g. made from particular cultivars, like the classical Pinot Noir, Pinot Meunier, Chardonnay, but also the well-known German Riesling Grapes., Sauvignon Blanc, etc. All together it gives an optimistic hope for future Danish sparkling wine production, since we have an almost optimal climate and presently also some cultivars like Solaris, Orion, Muscaris, Phoenix, Zarlas Perle, and Villaris, which growth and ripening properties are suitable for sparkling wine production.

Carl-Henrik Brogren, Hellerup, June 16, 2017.

LIST OF CONTENT.

SUMMARY

A short overview on bottled-fermented sparkling wine focusing on mainly the "tirage" additions to the basic still wines with new yeast, yeast nutrient, riddling aids, and sugar highlighting the pitfalls and hints during the secondary bottle fermentation.

New methods using agglomerated and encapsulated yeast for faster riddling and disgorgement and various aspects for alternative "dosage" with novel "liqueur d'expedition" are discussed. Various aspects of "sur-lie" development of aromas and flavor components in the bottles both before and after disgorgement is discussed.

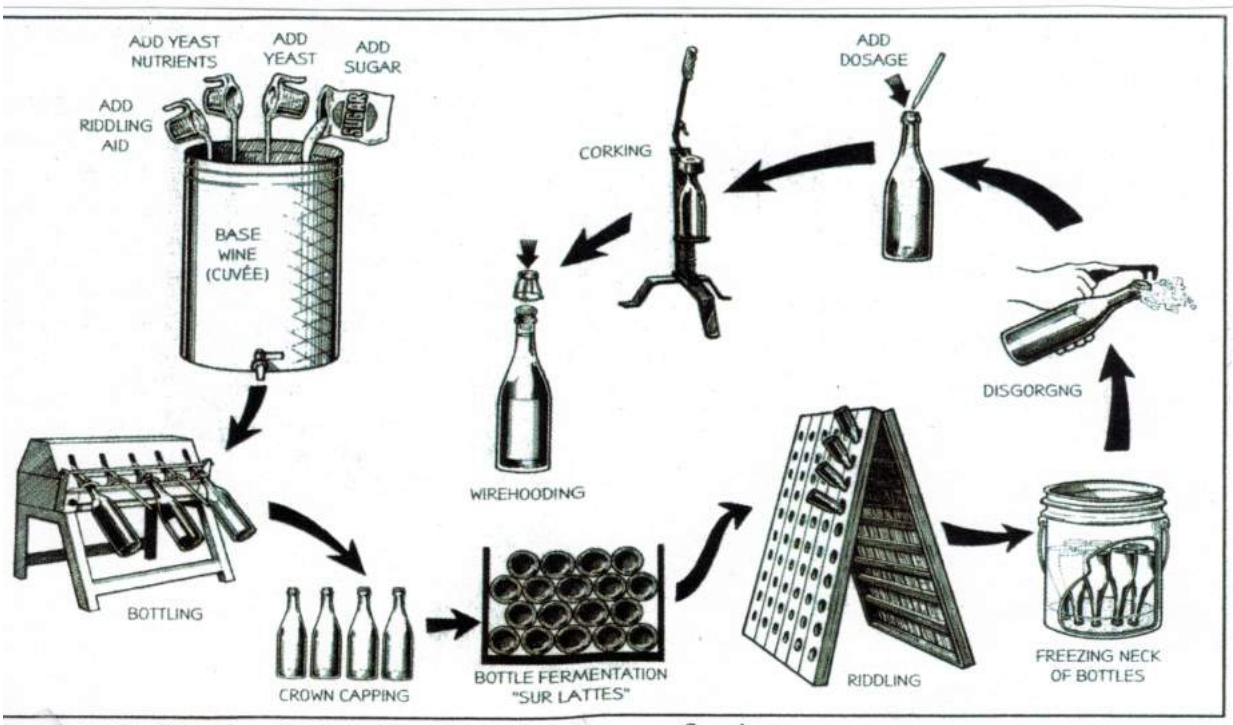
Novel grape cultivars for the Nordic cool climate viticulture and their application for sparkling wine production is an area for present exploitation. Conclusively, Denmark might have a future as sparkling wine producing country at an international level.

Personal experience with preliminary production of sparkling wines from Solaris and Orio grapes have highlighted pitfalls and hints for further improvements.

1. INTRODUCTION

Sparkling wine was discovered in England in the 17th century (Jackson 2014, p 705). Wine was imported from the Champagne region in northern France using oak barrels and then bottled in England in strong glass bottles, which after addition of lead oxide had become stronger. From the beginning of the 18th century, bubbly champagne became popular both in England and in France. Corks to close wine bottles are known seen late in the 16th century. The French monk Dom Perignon (1638-1715) dedicated his life to prevent fuzzy wines (a wrong research aim, I would say!), but however discovered that red grapes like Pinot Noir after fast pressing could make white wine, and soon the red cultivar Pinot Noir and Pinot Meunier became popular cultivar for sparkling wines later supplemented with the white cultivar Chardonnay. However, consumers demand forcing further development of the fuzzy wines after many accidents in cellars, in particular in the springtime, when the temperature increased. First much later in the 19th century (Francois 1837) it became known that adding sugar reactivates fermentation and induces a bottle pressure of 1 bar per 4 gram/L added sugar.

Figure 1 illustrates the commonly applied modern protocol for producing sparkling wine by bottle fermentation, but for unknown reason, this flow-scheme is incomplete (see also Fig. 1 in Jackson 2014), since no indication is given, that the second fermentation in the crown-capsule closed Champagne bottles needs addition of new yeast and also new yeast nutrients (Andrés-Lacueva et al. 1996, Jones et al. 2014, Kemp et al. 2015), which is a crucial part of a successful sparkling wine production (see Fig. 1 in Kemp et al. 2015 or the flowchart in Appendix A). The second bottle fermentation, riddling and disgorgement steps are further discussed below in relation to pitfalls and hints in the bottle fermentation procedure, while the optimal production of the basic still white wine will not be further discussed in this report.

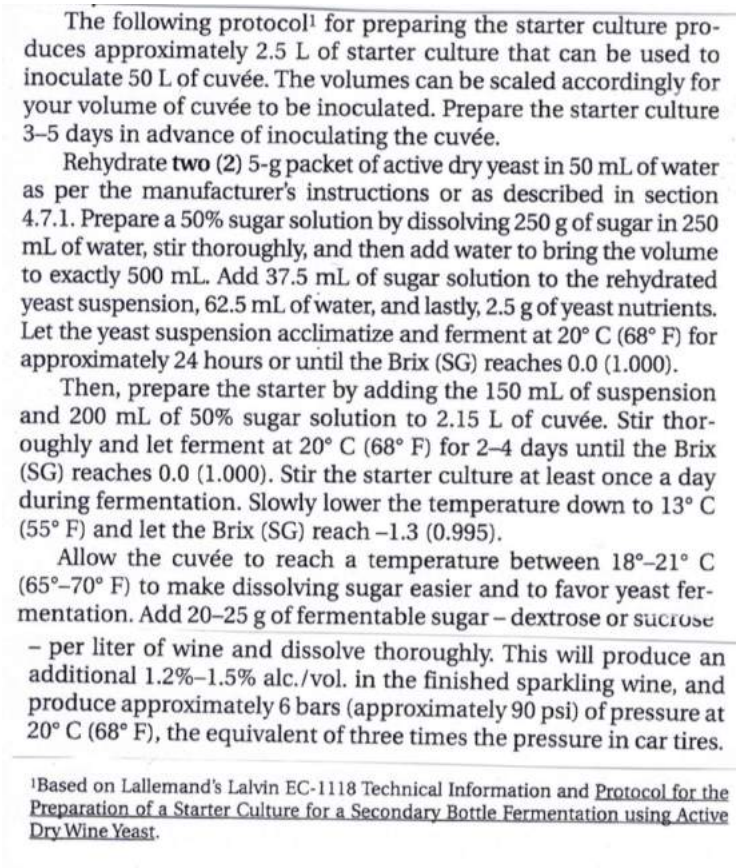


igure 11-1: Traditional method sparkling winemaking – process flowchart

***Fig. 1**: Flowcharts of traditional method for sparkling winemaking (Fig 11-1 in Pambianchi 2016)*

2. PRODUCTION OF SPARKLING WINES FROM GRAPES.

Grapes should be harvested with Oechsle value of 70-85 (Brix 17.0-20,4) sufficient to make a still white wine with 9-11 % v/v alcohol preferably without chaptalization. Sulfite is added at 50 mg/kg to harvested grapes, corresponding to approximately 30 mg/L in the pressed grape juice, to prevent wild yeast propagation and harmful bacteria in the juice. The acidity in the juice should be high (TA>10 g/L, pH=2.9-3.2), and therefore even partially immature grapes can be used in sparkling wine production. Grapes can be destemmed or not, but only the first, second and rearly third press can be used for sparkling wine, since the acidity in the juice decreases after additional pressing, and the potassium concentration also increases (see Fig. 9.21 in Jackson 2014), which however cannot explain the pH change since K+ is complete inert in acidity adjustment. Probably anionic organic acids or phenols of higher pK value or either inorganic buffering anions are released from skin or grape seeds which can precipitate our more tartaric acid, and thereby increase the pH in the juice. Furthermore, it is important to pre-clarify the juice by racking after 24 hours. After the first fermentation ends 2-4 weeks after harvest, a pH>3.0 is needed for a succeeding malolactic fermentation (MLF) can be done in all separate or blended still wine, which normally will take approximately one months at room temperature (20-24 ^{o} C)(Monrenzoni and Specht, 2015).



The following protocol[1] for preparing the starter culture produces approximately 2.5 L of starter culture that can be used to inoculate 50 L of cuvée. The volumes can be scaled accordingly for your volume of cuvée to be inoculated. Prepare the starter culture 3–5 days in advance of inoculating the cuvée.

Rehydrate **two** (2) 5-g packet of active dry yeast in 50 mL of water as per the manufacturer's instructions or as described in section 4.7.1. Prepare a 50% sugar solution by dissolving 250 g of sugar in 250 mL of water, stir thoroughly, and then add water to bring the volume to exactly 500 mL. Add 37.5 mL of sugar solution to the rehydrated yeast suspension, 62.5 mL of water, and lastly, 2.5 g of yeast nutrients. Let the yeast suspension acclimatize and ferment at 20° C (68° F) for approximately 24 hours or until the Brix (SG) reaches 0.0 (1.000).

Then, prepare the starter by adding the 150 mL of suspension and 200 mL of 50% sugar solution to 2.15 L of cuvée. Stir thoroughly and let ferment at 20° C (68° F) for 2–4 days until the Brix (SG) reaches 0.0 (1.000). Stir the starter culture at least once a day during fermentation. Slowly lower the temperature down to 13° C (55° F) and let the Brix (SG) reach –1.3 (0.995).

Allow the cuvée to reach a temperature between 18°–21° C (65°–70° F) to make dissolving sugar easier and to favor yeast fermentation. Add 20–25 g of fermentable sugar – dextrose or sucrose – per liter of wine and dissolve thoroughly. This will produce an additional 1.2%–1.5% alc./vol. in the finished sparkling wine, and produce approximately 6 bars (approximately 90 psi) of pressure at 20° C (68° F), the equivalent of three times the pressure in car tires.

[1]Based on Lallemand's Lalvin EC-1118 Technical Information and Protocol for the Preparation of a Starter Culture for a Secondary Bottle Fermentation using Active Dry Wine Yeast.

Fig. 2*: Protocol for initiating the secondary fermentation in the sparkling bottle wine production by the so-called "tirage"(see page 386-7 in Pambianchi 2014)*

As depicted in Fig. 2, the secondary fermentation needs a careful and dedicated handling of the basic still wine, the new added yeast supply, the yeast nutrients adjustment, and the pressure adjusted sugar addition. Preferably, a 11 % v/v alcohol containing still wine with no residual sugar

content form the basement for the second fermentation. This still wine can be made as classical white wine without clarification, malolactic fermentation, and oak barrel storage, but since major flavors and aroma compound of primary and secondary origin, come from the grape source, fermentation step, and spontaneous or induced malolactic fermentation is done, plus eventually even a 1st fermentation in oak barrels with yeast "batônnage "(used by Ørnberg Vin, Denmark). Therefore, everything which might improve sparkling, flavors and appreciable tastes in the still wine is of great importance for the final sparkling wine quality (Andrés-Lucueva et al, 1996, Jones et al. 2014, Kemp et al. 2015, Toldam-Andersen 2017). The still wine can preferable be made with selected yeast type, like Springer S325, developing more glycerol, while in the second fermentation established sparkling wine yeast sources, like Lalvin EC-1118 or Lalvin DV-10, which in Denmark is quit commonly in use for sparkling wine.

Pambianchi (2016) describes in all details a protocol for the secondary fermentation which uses 10 g dry yeast per 50 L still wine (blended or not). The rehydration of dry yeast is essential and need often help from Go-Ferm (Lalvin), a lysate of died yeast and minerals (Sigrid Gertsen-Schibbye, personal communication). I have personally, used DV-10 (30 gram/100 L) as both the primary and secondary yeast in starter culture without "Go-Ferm" addition, but used supplement of Fermaid (Lalvin) yeast nutrients as recommended by the manufacture.

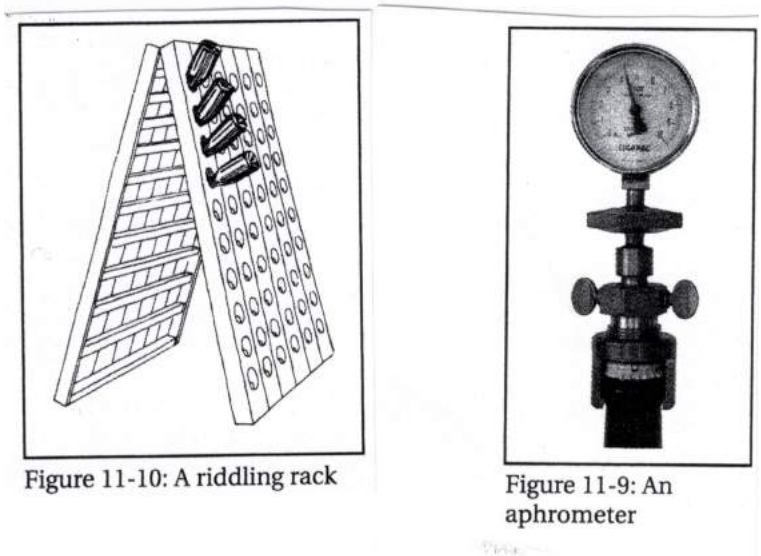


Fig. 3. *Classical Riddling rack ("pupitre") used before disgorgement (left) and bottle manometer (aphrometer) used to follow the pressure development during the secondary bottle fermentation. (Ref. Fig. 11-10 and 11-9 in Pambianchi 2016)*

As pointed out by Andreas Mugler in Germany (personal communication), adaptation of the starter culture yeast suspension to the still wine alcohol content and acidity is of great importance for a fast and efficient 2nd fermentation without fermentation stop. To ensure optimal bottle pressure of 6 bar requires the addition of 24 g sucrose disaccharide or glucose monosaccharides (dextrose) pr. L. The bottle pressure and time span of the 2nd fermentation can be followed mounting an aphrometer (bottle manometer) on top of one bottle from each batch (Fig. 3 right). Therefore, it is recommended over 1-2 days to stepwise adapt the starter culture to the still wine by blending it with still wine and adjust it to the same temperature (Mugler 2017, personal communication).

To ensure a fast start of the second fermentation, I will recommend to add the starter culture to the racked and semi-clarified still wine at room temperature (20 C) and under carefully stirring to bottle the starter culture, yeast nutrient and additional sugar supplemented 2nd fermenting

sparkling wine into heavy (>750 gram) champagne 75 cL bottles or half 37.5 cL bottles, immediately closed by "bidule" crown capsules, having a chamber for yeast collection before disgorgement.

The champagne bottles should after 1-2 days be transferred to the wine cellars at 13-15 C, for the secondary bottle fermentation, where the bottles normally are stored horizontally for the best yeast contact and weekly should be shaking occasionally but they can also be stored up-site down with a slower fermentation rate (see Fig. 4).

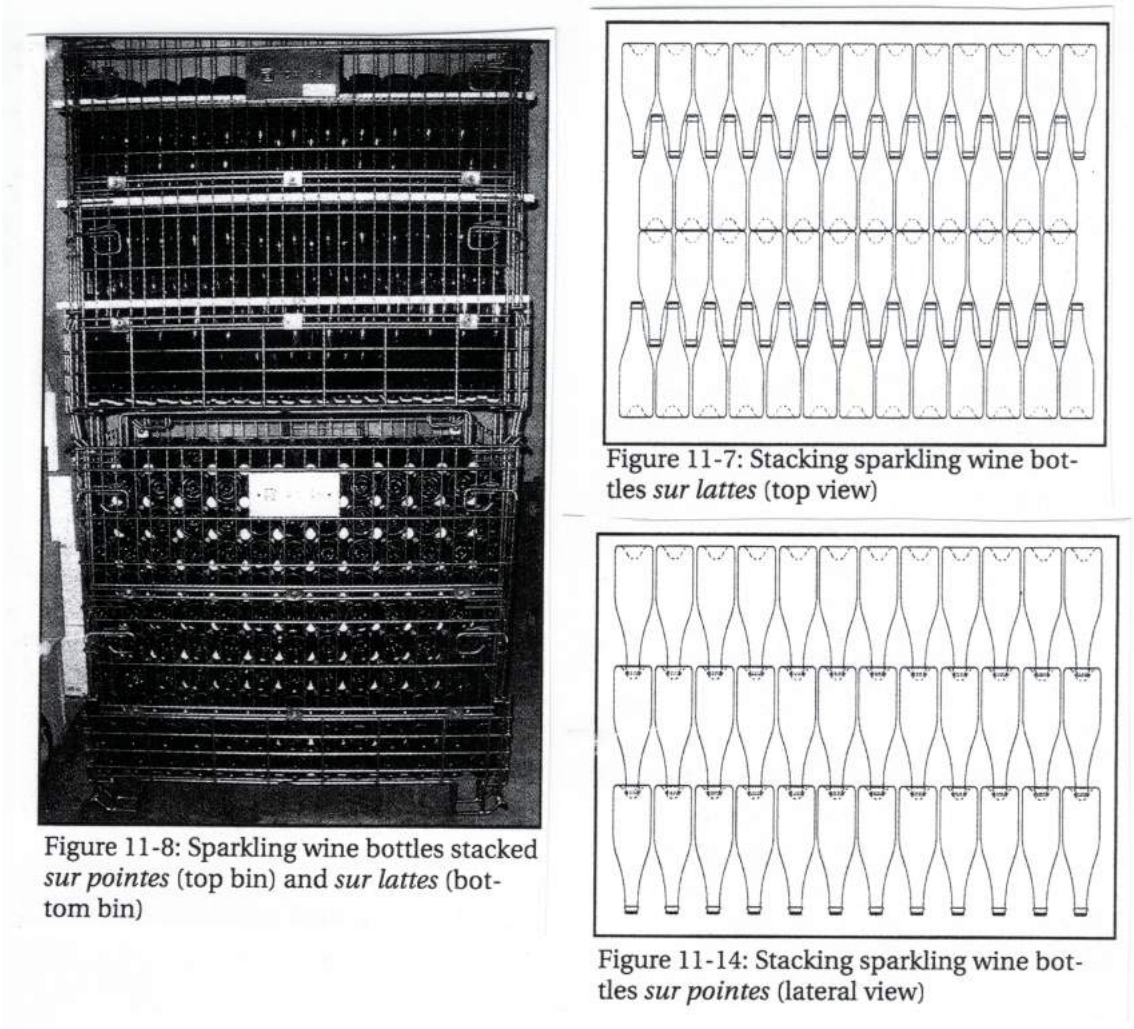


Fig. 4. *Sparkling wine bottles storage in wine cellars during the 2nd bottle fermentation with or without riddling procedure. (ref. Pambianchi 2016, fig. 11-7, 11-8 and 11-14)*

The most important time-period in sparkling wine production is the horizontal storage "sur lattes" (Fig. 4), the cellar storage period during and after ending the 2nd bottle fermentation, where important secondary aroma components are released from autolysis of the yeast. This period can vary from more than 18 months obligatory in the French Champagne district, to 6-9 months in many cellars producing the Crémant type sparkling wine all around the world. A common standard in Germany, Bourgogne and Bordeaux seem to be 9 months "sur lie" (with yeast in the bottle), and after disgorgement 3-month further storage seem common. Altogether, this makes a 12-month production period from harvest to sale, enough time to release the bottle for New Year celebrations.

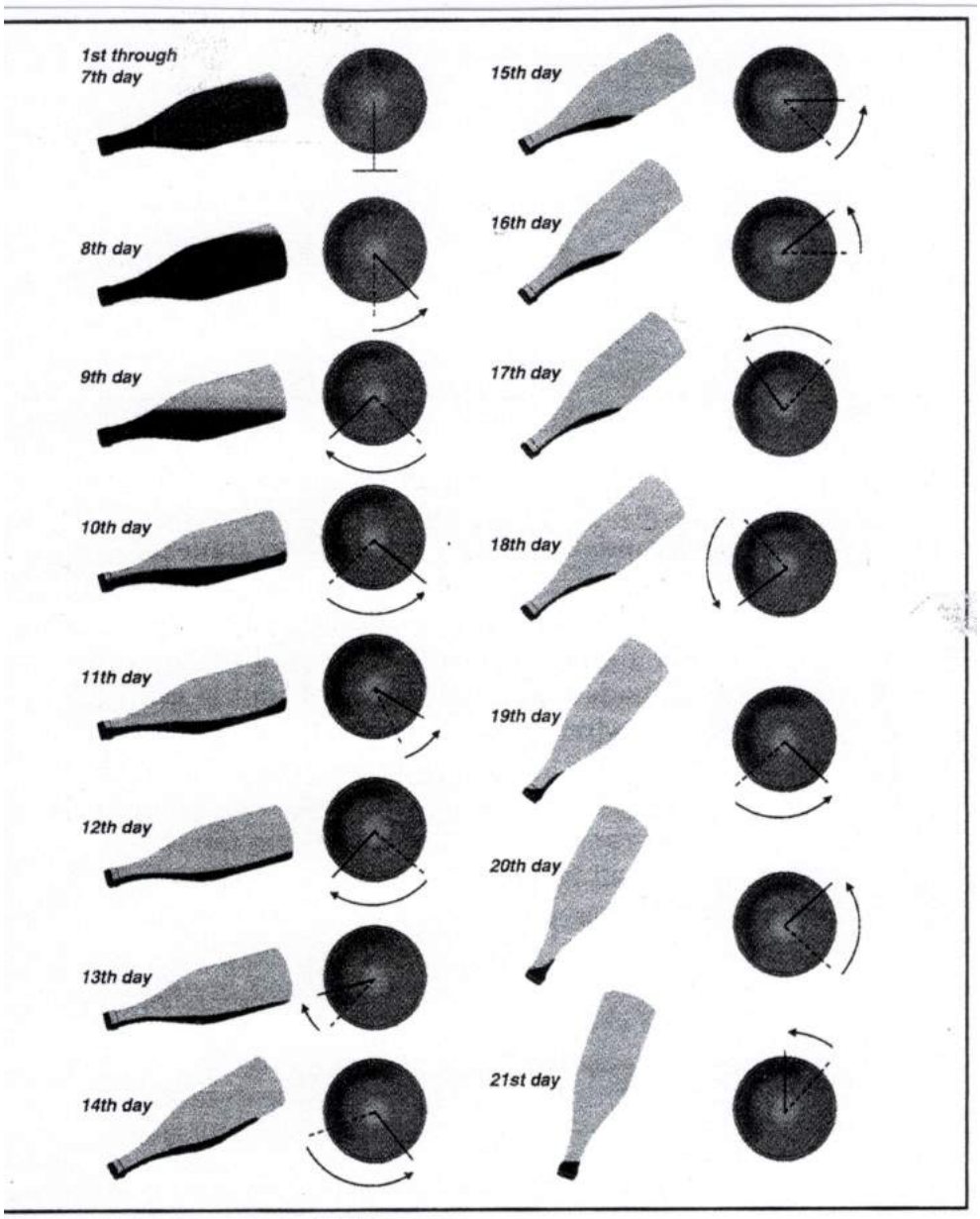


Figure 11-11: Standard riddling program

Fig. 5*: three weeks riddling program before disgorgement of settled yeast from the 2nd fermentation (Fig. 11.11 from Pambianchi 2016)*

After ending of the secondary bottle fermentation (normally 1-2 months), the removal of yeast and eventual sediments (tartaric acid) can be done either in a "pupitre" (Fig. 3 left, Fig. 5), or simply by transferring the bottles form horizontal to up-site-down position (Fig. 4 "sur pointes"). Modern larger wineries use special automatic riddling machine, a so-called gyropalettes. Even easier for smaller wineries is the use of various immobilized encapsulated yeast (algitates, biocapsules). Lalvin (Canada), Chr. Hansen (Denmark) and Proenol (Portugal) are all known producers of these new kind of yeast products, which easily can be disgorged without the time-

consuming riddling period (Foulonneau 2014, Kemp et al. 2015). Furthermore, yeast inserted by dialysis tubing method can be easily removed without riddling (Pambianchi 2016, p. 401).

Finally, the collected yeast in the neck by riddling (Fig. 5) can be removed by disgorgement after initial freezing of the bottle neck placed in a freezing solution in a floor deep freezer (-18^{o} C). Approximately 10 minutes after insertion of the neck in the freezing solution an ice-block is formed, which after capsule removal with a disgorgement key (reversed bottle opener), will shoot out an ice block containing residual yeast and other sediments and thereby clarify the sparkling wine. A new fashion in French restaurants is to perform disgorgement immediately before serving even in the restaurant room, which further increases the pricing of Champagne serving.

Table I: *Residual sweetness in sparkling wine is adjusted by "dosage" addition after disgorgement (Table I1-1 from Pambianchi 2016)*

Table 11-1
Residual sugar (RS) guidelines for common styles of sparkling wines from around the world

Style	RS (g/L)	Also known as (see note)
Extra Brut	0–6	Brut de Brut (F) Brut Nature (F) Non Dosage (F) Bone Dry (US)
Brut	0–15	Bone Dry (US)
Extra Dry	12–20	Extra Sec (F) Extra Trocken (G)
Dry	17–35	Sec (F) Trocken (G) Secco (I)
Off-Dry (Semi-Dry)	35–50	Demi Sec (F) Doux (F) Halbtrocken (G) Abboccato (I) Medium Sweet (US)
Sweet	50 & over	Doux (F) Dolce (I)

Note: F=France, G=Germany, I=Italy, US=United States

To adjust the sweetness of the final sparkling wine but also to stabilize for oxidation and bacterial spoilage, the disgorged bottles are topped up with an additional so-called "dosage", or expedition-liqueur, containing both residual sugar and sulfite. This liqueur can either be grape concentrate, selected alcohols (Cognac), or readymade "dosage champ" liquid from a commercial source.

The final corking needs a special corking machine able to insert the recommended large 48 x 30.5 mm 2-layer agglomerated corks (Amorim, Portugal), plastic champagne stopper, or new designed replacement stopper – the SPK Zork system (seen at MODAVI Vingård, Kolding).

Occasionally, Champagne bottle (after chilling) can be opened also by "sabrage", which mean removing the bottle neck by a sable, machete, back-site of a large knife, or even the foot of a wine glass. This method was invented by the officers in the Napoleon army.

The final storage time of disgorged and corked champagne bottles is normally 3 months, which then makes sparkling wine of the Crémant type, commercially available 12 month (1

year) after grape, and in the Reims Champagne region after 24 months (2 years). Certain famous Champagne houses store Champagne bottle "sur lie" for an even longer time up to 10 years or more, with a doubtful significant flavor improvement.

It is still not obligatory to indicate the disgorgement date to classify the final product of sparkling wine. However, the various type of sparkling wine is classified according to sweetness, and range from "Extra Brut", "Brut", "Extra Dry", "Dry", "Semi-Dry" to "Sweet", with similar indications in French, German, Italian, and Spanish (see Table I above). The Brut sparkling wine is preferred with sea-food (oysters, shrimps, fish) and dry cheese, while the sweeter sparkling wines are served to deserts, and should be used for sweet cake, like "kransekagen" New Year evening (Puckette and Gammack, 2015)**.** Alternative to the "method traditionelle" sparkling wine is also produced by carbonation (Lambrusco).

3. DISCUSSION OF PITFALLS AND HINTS

In relation to the above described protocols and recommendations for production of sparkling wine, in addition from making both an apple and pear cider production. we have gained important experiences from our own first sparkling wine and cider production in 2016 and 2017,

The acidity of the harvested grapes should be relative high, because highly mature grapes are not optimal for sparkling wine production. However, aroma components develop in a late stage of maturation, and Malic acid content decreases during maturation. The ripening status of the grapes should however be at the level being able to produce a still wine with a final alcohol content of approximately 11% v/v without chaptalization. A too high acid content can be balanced with calcium carbonate addition and if too low with citric acid. The basic still wine should be able to undergo a succeeding malolactic fermentation either spontaneous or after adding *Oenococcus oeni* bacteria, which removes bitterness. This is commonly done in the Champagne district.

The 2nd bottle fermentation should by conducted with care and precision, adapting the new starter culture to the alcohol containing wine cuvee (still wines), to ensure a fast initiation and continued fermentation of bottle fermentation and ensure no fermentation stop, before the optimal 6 bar pressure has been obtained. Typical reasons for fermentation stop in the secondary bottle fermentation are missing adaptation of the yeast to the alcoholic still wine, or lack of yeast nutrient like nitrogen sources or in particular deficient thiamin B-vitamin content.

Minerals like excess of magnesium are important for the termination of the bottle fermentation within a reasonable time. This argues for an addition of Lalvin "Go-Ferm" additive to the secondary yeast addition.

Most sparkling wine producers add riddling aids like Compactless (Sekt-Klar), bensonite, but professional producers might also add "Gum Arabic" for improve foaming and tannin as an antioxidant. The increasing interest for "bio- organic" sparkling wines aim not to use additives, even not sulfite.

The bottle fermentation and successive "sur lie" aging and autolysis of yeast are important for the development of sufficient flavor or development of aroma components.

The final bottle closure is normally done with Champagne corks, but the disgorged bottles can also simply be closed with new crown-caps or plastic stopper. We have in our own small production been fighting with corking problems using an Italian Ferrari Champagne corker with Amorim champagne corks (48 x 30.5 mm). Alternative champagne corks (48 x 29.5 mm) delivered as a gift from Amorim in Germany are now on trial.

To eventually make some innovation for Danish sparkling wine production, we will in late 2017 investigate the possibility to produce a "Kir Royal" sparkling wine by performing the secondary fermentation with a mixture of grape wine and blackberry wine. It was already tried in late spring

2017, after disgorgement to use a "dosage" of 5 x concentrated blackberry juice, and in parallel with other fruit juice concentrates from marble syrup, blueberry juice, etc.

Blue grapes and white grapes from the palace garden of Fredensborg Castle will probably in the 2017 harvest be included in our vinifications, which enables us to produce also a "Crémant Rose" by blending red and white still wines. At the same time, it will allow "Bernstorffs Frugt og Vinlaug" to experiment with new Danish cultivars in our sparkling wine production, e.g. from "Zarlas Perle" grape juice and some red grapes cultivars, like Rondo, Regent and Leon Millot.

Like Cognac have been used in the "dosage" expedition liqueur, most likely grape Marc can also be used. A further investigation of this approach in our own sparkling wine production is needed.

The cool climate viticulture typical for Denmark and other Nordic countries makes production of high quality red wine unlikely. However, our climate predicts a possible high quality sparkling wine production possible. FDV (Foreningen Danske Vin) has established an ERFA group for sparkling wine, where common challenges can be discussed, and this network is also available for some of the winemaker members of "Bernstorffs Frugt og Vinlaug". Apart from the grape sparkling wine, we gain experience from our parallel cider production, which included both apple cider and pear cider made after the "method traditionelle", using the two step fermentation methods.

Champagne connoisseurs and winemakers with special interests for the sparkling wine production are recommended to consult the review by Kemp et al. (2015) for further studies, since all steps and all possible aspects in the "fuzzy" wine production are reviewed carefully in the article. An overview flowchart from this review can be found in Appendix A.

Additionally, some details about sparkling wines made from still wines in a German contract production by Norbert Bardong is described in a recent article (Toldam-Andersen, 2016). A similar approach to initiate Danish Sparkling wine production might be relevant since many Danish winemakers find sparkling wine production too complicated.

4. CONCLUSION

Sparkling wine production with bottle fermentation using the classical "methode traditionelle" used all over the world can successfully be done also in Denmark from a large variety of grape cultivars, which fully or partially will maturate in the Danish cool climate viticulture management. This optimally needs twice the canopy leave area per gram of grapes (20 cm2 per gram grapes corresponding to 14 leaves per cluster) compared to vineyards in the souths of Europa. Even Pinot Noir can be ripened in certain area of Denmark (e.g. Sjællands Odde, Ørnberg Vingård), but the major cultivars for sparkling wine production in Denmark is still Solaris, Orion, Phoenix, Muscaris, Zarlas Perle, Johannitter and recently also Villaris, which so far are among the most popular cultivars for sparkling wine grape sources in Denmark.

I special care should be taken in the initiation of the second fermentation, to ensure a fast and complete bottle fermentation reaching the wanted bottle pressure of 6 bar. Yeast adaptation to the alcoholic base wines are important but extra addition of yeast nutrients are also important in addition to the calculated amount of fermentable sugar (sucrose or glucose).

Riddling aids are commonly added to avoid glass wall attached precipitates, and also enable easier clarification before the disgorgement process. Novel encapsulated yeast is developed for faster or no riddling needed, and new replaceable closures are seen on the market.

Flavor and aroma components development during bottle storage "sur lie" need further investigation from the Danish cultivars. Aging after disgorgement also improve tertiary aromas and needs further investigation.

5. REFERENCES.

Andrés-Lacueva, C., López-Tamames, E., Lamuela-Raventòs, R.M., Buxaderas, S., and Torre-Boronat del a, M.C. (1996): Characteristics of Sparkling Base Wine Affecting Foam Behavior. *J. Agric. Food Chem. 44,* 989-995

Foulonneau, C. (2014): *La Vinification*, 4th edition, Donud, Malakoff, (in French)

Francois, M. (1983): *Traité sur le travaille des Vins blanc Mousseux*. Impremeur de Bonier-Lasmber, Châlon-sur-Marne, France, (in French).

Gertsen-Schibbye, S. (2017): Lallemand, Canada and Lalvin Europa office, Denmark). (Personal communication)

Gundersen J.M. and Génsbøl, B. (2015): *Vinavl i Danmark*, Gyldendals, Copenhagen (in Danish)

Jackson, R.S. (2014). *Wine Science, Principles and Application.* Academic Press. Elsevier, Amsterdam, 4th edition.

Jones, J.E., Kreslake, F.L., Close, D.C., and Dambergs, R.G. (2014): Viticulture for Sparkling Wine Production: A review. *Am. J. Enol.Vitic. 65* (4), 407-416

Kemp, B., Alexandre, H., Robilland, B., and Marchal, R. (2015): Effect of Production Phase on Bottle-Fermented Sparkling Wine Quality. *J. Agric. Food Chem. 63*, 19-38 (review)

Mariaule, M and Winter, G. (2013): *Oenolixecon* – English-French/French-English. Féret, Bordeaux, France.

Morenzoni, R. and Specht, K.S.(eds) (2015): *Malolactic fermentation – Importance of wine lactic Acid bacteria in winemaking*. Lallemand, Quebec, Canada.

Mugler, A. (2017). Kellerrei Andreas Mugler, Reingau, Germany. (Personal communication).

Pambianchi, D (2016): *The Techniqies in Home Winemaking - A practical guide to making château style wine*. Véhicule Press, Ontario, Canada. 1st edition 2008 and 2016

Puckette, M and Hammack, H. (2015): *Wine Folly – the essential guide to wine.* Wine Folly LLC, New York, USA.

Toldam-Andersen, T.B. (2017): Sektfremstilling in Rheingau, Vinpressen, #2.17, p. 20-22. (In Danish)

APPENDIX A

An extended flowchart for sparkling wine production (Ref: Kemp et al. 2015 (Fig.1))

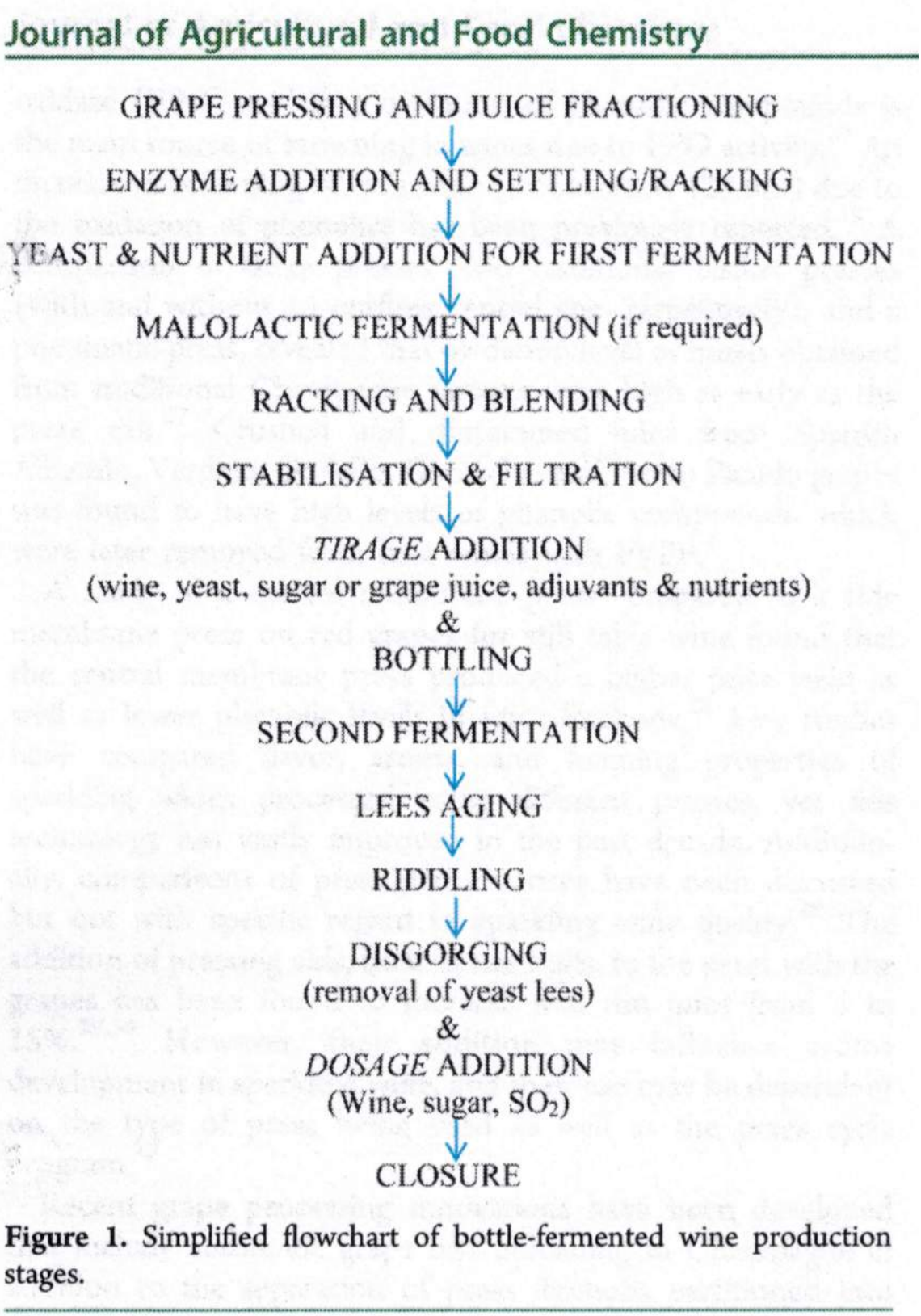


Figure 1. Simplified flowchart of bottle-fermented wine production stages.

APPENDIX B.

FOSS Winescan data from the two basic still white wines (from our Solaris and Orion cultivars harvested in 2016) used separately and for blending in sparkling wine production after "méthode traditionelle" by "Bernstorffs Frugt og Vinlaug" in 2016-2017.

Sample Id	Rep #	Product	pH	MalicAcid	Ethanol	Sulfuric acid TotalAcid	calculated as Tartaric acid TotalAcid	VolatileA.	LacticAc
Orion Bernstor		1 Færdig vin Pometet ny	3,68	0,56	9	2,36	3,61	0,17	1,86
Orion Bernstor		2 Færdig vin Pometet ny	3,7	0,61	8,99	2,39	3,66	0,17	1,89
Orion Bernstor	Gns.	Færdig vin Pometet ny	3,69 x	0,59	9 x	2,37	3,63	0,17	1,88
Orion Bernstor	Sd	Færdig vin Pometet ny	0,012	0,035	0,01	0,015	0,02	0,003	0,02
Solaris Bernst		1 Færdig vin Pometet ny	3,34	0,26	11,73	4,18	6,40	0,36	1,48
Solaris Bernst		2 Færdig vin Pometet ny	3,32 x	0,28	11,74 x	4,18	6,40	0,35	1,48
Solaris Bernst	Gns.	Færdig vin Pometet ny	3,31	0,27	11,73	4,18	6,40	0,35	1,48
Solaris Bernst	Sd	Færdig vin Pometet ny	0,003	0,011	0,006	0,001	0,00	0,008	0,004

Sample Id	Rep #	Product	Fructose	Glucose	TartaricA.	Density	Glycerol	CO2	FolinCindex	ReducingSuga Da
Orion Bernstor		1 Færdig vin Pometet ny	3,02	2,13	1,58	0,99639	4,77	1105,44	15,7	4,53
Orion Bernstor		2 Færdig vin Pometet ny	2,9	1,92	1,48	0,99651	4,69	1100,03	15,15	4,28
Orion Bernstor	Gns.	Færdig vin Pometet ny	2,96 x	2,03 x	1,53	0,99645	4,73	1102,74	15,42	4,41 x
Orion Bernstor	Sd	Færdig vin Pometet ny	0,088	0,148	0,073	0,000083	0,053	3,83	0,388	0,182
Solaris Bernst		1 Færdig vin Pometet ny	3,76	2,04	3,38	0,99419	4,07	1039,9	18,32	5,43
Solaris Bernst		2 Færdig vin Pometet ny	3,58	2,06	3,29	0,99417	4,04	1043,14	18,7	5,24
Solaris Bernst	Gns.	Færdig vin Pometet ny	3,67 x	2,05 x	3,34	0,99418	4,05	1041,52	18,51	5,33 x
Solaris Bernst	Sd	Færdig vin Pometet ny	0,126	0,013	0,063	0,00001	0,021	2,294	0,27	0,137

5.0 g/L

5.7 g/L