A Brandy Aroma Wheel for South African Brandy*

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A Brandy Aroma Wheel was developed incorporating standardised descriptive terminology (descriptors) for South African brandy aroma. The wheel comprises two tiers of descriptors with 18 first-tier descriptors giving a broader definition of an aroma, while the 75 second-tier descriptors give a more precise definition. Reference standards have been developed for the second-tier descriptors. Brandy aroma scorecards have also been developed for use with the Brandy Aroma Wheel.

South African brandy is a blended product. A detailed knowledge of the aroma and flavour qualities of the individual components is an essential component of the skill needed to combine individual brandies into a recognisable standard product. These skills are found in a small group of experts scattered throughout the industry. These experts, normally working in small groups within a company, tend to develop company-specific vocabularies. This has led to the use of different terminology to describe the same aroma nuance. Company-specific terminology is often difficult for outsiders to understand. Such non-standardised terminology also reduces the value of brandy evaluation data, making the interpretation of research results more difficult.

The ideal product descriptive vocabulary should consist of terms that describe the aroma and are understood by the experts, who agree with each other regarding their meanings (Piggot, 1991). The general public (consumer) should also understand this vocabulary. To assist in training new judges and to ensure that experts from different companies refer to the same aroma nuance, it is necessary to have a set of reference standards that can be used to illustrate the meanings of terms (Meilgaard *et al.*, 1982; Noble *et al.*, 1987; Piggot, 1991).

Other industries have developed standardised terminology to describe the aroma of their products. These include cider and perry (Williams, 1975), whisky (Shortreed *et al.*, 1979; Piggot & Jardine, 1979; Piggot, 1991), beer (Meilgaard *et al.*, 1979), wine (Noble *et al.*, 1984, 1987), sparkling wine (Noble & Howe, 1990), olive oil (Aparico & Morales, 1995; Servili *et al.*, 1995) and fruit juice (Muir *et al.*, 1998). The standardised industry-specific terminology is usually presented in a wheel format. Some of the terminology is coupled to reference standards (Meilgaard *et al.*, 1982; Noble *et al.*, 1987; Piggot & Jardine, 1979; Piggot, 1991). As far as we are aware, no aroma wheel has been developed for brandy.

The aim of this study was therefore to develop standardised aroma terminology for the description of South African brandy. Furthermore, the terminology had to be accessible to the two largest language groups in the brandy industry i.e. Afrikaans and English. A tasting scorecard incorporating the terminology of the Brandy Aroma Wheel and reference standards also needed to be developed.

MATERIALS AND METHODS

Brandy Aroma Wheel

The first phase of the project consisted of the compilation of a list of 61 terms (descriptors) used to describe brandy aroma (Guymon, 1974; Venter, 1994a, 1994b; Le Roux, 1997; H. Haarhoff, personal communication, 1995). A further 50 descriptors were added following discussions with South African brandy experts (distillers, blenders and other production personnel). As brandy is distilled from grape wine, the terminology was further supplemented with 94 descriptors. These appear in the third tier of the Wine Aroma Wheel (Noble *et al.*, 1984, 1987). Cognac terminology was not incorporated. The procedure used for the development of the Whisky Aroma Wheel was used as a guideline for the development of the Brandy Aroma Wheel (S. Burtles, G. Richardson & J.R. Piggot, personal communication, 1996).

During the second phase of the project, 21 members of the brandy industry helped to select the most commonly used descriptors (both English and Afrikaans). Thereafter the necessary translation and standardisation were done. Subsequently, the relevant descriptors were grouped under first-tier descriptors. For this the wine aroma (Noble *et al.*, 1984, 1987) and whisky aroma wheels (Shortreed *et al.*, 1979) were used as models. A Preliminary Brandy Aroma Wheel was formulated with 18 first- and 68 second-tier descriptors (data not shown). The Preliminary Wheel was evaluated by the brandy industry over a period of 3 months. Subsequently, a core group of seven brandy experts advised on the necessary modifications. Thereafter, the final version of the Brandy Aroma Wheel was formulated.

Development of reference standards

Sensory panels: A group of 21 persons, including experienced wine tasters, were trained in sensory evaluation according to procedures used by the Scotch Whisky industry (G. Richardson, J.R. Piggot & E. Pitt, personal communication, 1996). This group was used for the

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development of the standards regarding the coupling of specific aroma sources to the terminology and for judging a range of concentrations of individual aroma compounds to ascertain the most appropriate concentration (aroma intensity). Concurrently, a separate panel of seven brandy experts advised on brandy aroma. This expert panel also judged the standards developed by the research team and the first panel. Their judgement was used as the final criterion for the acceptance or rejection of a standard.

Reference standards: The reference standards were developed by testing the suitability of a range of 165 pure chemicals, nature identical flavourants, natural extracts, essential oils and whisky standards (Piggot, 1991). These compounds were selected on the basis of aromas related to brandy descriptive terminology. The standards were prepared in 95% ($^{V}/_{V}$) ethanol diluted to 23% with distilled water. If the compounds were not soluble in 23% ethanol, distilled water or propane 1,2-diol was used. Sixty-four reference standards linked to second-tier descriptors were formulated as shown in Table 1. Reference standards were made up 24 h before use and were evaluated by smelling only. No reference standards were linked to six descriptors, i.e. 'lees oil', 'oily', 'cigar box/tobacco pouch', 'musty barrel', 'musty cork' and 'scorched'. Reference standards (30mL) were evaluated in blue

TABLE 1

Reference standards and recommended concentrations for use with the second tier descriptors of the Brandy Aroma Wheel.

Second-tier descriptor	**Reference standard[1]**	**Concentration[2] in 23% ethanol[3] (unless otherwise stated)**
Soapy	C6 (Ethyl caproate [Sigma-C9884]), C8 (Ethyl caprylate [Sigma-C3250]), C10 (Ethyl caprate [Sigma-C0760]) esters	0,01% in a 1:1:1 ratio
Butter	H&R Butter (81112)LR15886	0,1% in propane 1,2-diol[4]
Tea/Hay/Straw	Ceylon tea leaves (Joko brand)	Use one standard teabag and soak in 250 mL freshly boiled water for 2 min, decant and cool liquid to room temperature
Malt	D Malt 6/054174)	5%
Grassy	UF cis-3-hexen-1-ol 17346	0,01%
Minty	H&R Peppermint oil (OSI) 33772	0,001% in propane 1,2-diol[4]
Eucalyptus	B&F Eucalyptus	0,5% in propane 1,2-diol[4]
Buchu	H&R Buchu	191774 0,001% in propane 1,2-diol[4]
Peach (fresh)	H&R Peach 15887	0,1%
Peach (dried)	Dried peaches	Soak four dried peaches for 24 h in 40 mL 23% ethanol, decant and use 30 mL liquid
Apricot	Apricot jam (All Gold brand in glass bottle)	Use as is
Apricot (dried)	Dried apricot (SAD brand)	Soak 4 dried apricots for 24 h in 40 mL 23% ethanol, decant and use 30 mL liquid
Prune	Dried prunes (SAD brand)	Soak 4 dried prunes for 24 h in 40 mL 23% ethanol, decant and use liquid
Grape	White grape juice (non-Muscat variety)	Use undiluted
Fig	Dried figs (SAD brand)	Soak 4 dried figs for 24 h in 40 mL 23% ethanol, decant and use liquid
Apple	D Apple 91034925	0,01% in propane 1,2-diol[4]
Citrus	H&R Grapefruit oil 100280	0,01%
Estery/Synthetic fruit	iso-Amyl-acetate AR (BDH 10037 5L)	0,012%
Muscat	Paarl Rock Hanepoot brandy	Use as is or dilute to 23% ethanol
Hanepoot grape (Muscat d' Alexandrie	Hanepoot sweet wine	Use undiluted
Raisin	D Muscat 9/036476	1%
Rose	ß-Phenyl ethanol (BDH 29505 4W)	0,01% in propane 1,2-diol[4]
Potpourri	B&F Geranium	0,05% in propane 1,2 diol[4]
Dusty/Plank	French Oak shavings	French Oak shavings toasted at 230°C for 2 h
Vanilla	H&R Vanilla 1376	0,01%
Oak	French Oak extract	French Oak shavings toasted at 220°C for 2 h. Make a 100g/L ethanol (55%) extract by incubation for 24 h at 30°C and 48 h at 20°C. Follow by boiling under reflux for 5 h
Cedar wood	H&R Cedar 100109	0,001% in propane 1,2-diol[4]
Resinous	B&F Pine	0,1% in propane 1,2 –diol[4]
Coffee	D Coffee 9/034416	1%

Second-tier descriptor	Reference standard[1]	Concentration[2] in 23% ethanol[3] (unless otherwise stated)
Smoky	H&R Smoke 94275	0,1% in propane 1,2 –diol[4]
Hazelnut	D Hazelnut 9/027064	0,1% in propane 1,2-diol[4]
Almond	H&R Benzaldehyde 162013	0,005% in propane 1,2-diol[4]
Walnut	D Walnut 6/063326	1%
Flor Sherry	South African Dry Flor (similar to Spanish Fino Sherry)	Use undiluted
Port	South African Tawny (Similar to Portuguese Tawny Port)	Use undiluted
Sherry(sweet)	South African Full Cream (Similar to Spanish Oloroso Sherry)	Use undiluted
Molasses	Cane sugar molasses	Use undiluted. (Obtained from sugar refinery or health shops)
Chocolate	D chocolate 9/693593	0,1%
Caramel/Toffee	Moir's Caramel essence	1%
Honey	Natural light coloured honey	Use undiluted
Strawberry jam	All Gold Strawberry jam (glass bottle)	undiluted
Cinnamon	H&R Cinnamic aldehyde ES4040	0,1%
Cloves	H&R Eugenol 608025	0,01%
Nutmeg	H&R Nutmeg OR 17-06 191366	Use small piece (2 g) of the oleoresin
Detergent	1-Decanol AR (BDH 28003 4Q)	0,012%
Ethyl acetate	Ethyl acetate (BDH 10108 4H)	0,01% in water
Acetone	Acetone (BDH 10003 3P)	1% in water
Ethanol	Ethanol AR (BDH 10107 6H)	23% in water
Acetic acid	Acetic acid (BDH 10001 3L)	0,1%
Vinegary/Vinous	Wine vinegar (SAD Wellingtons brand)	Use undiluted
Rancid/Butyric acid	Butyric acid GPR (BDH 27535 4V)	0,01%
Mushroom	H&R Mushroom 49224	0,01%
Wet cardboard	Brown cardboard	Five grams brown cardboard in 50mL water. Decant/filter and use liquid after 24 h
Paper	Paper	Five grams white paper (fax, laser, inkjet – 8gm^2) with no print in 50 mL distilled water. Decant/filter and use liquid after 24 h
Garlic	D Garlic 9/500917	0,01% in propane 1,2-diol[4]
Cabbage	Fresh cabbage leaves	Soak cabbage (5 g) in 50 mL distilled water for 24 h. Decant/filter and use liquid
Sulphur dioxide	SO_2 solution	0,1% in water
Hydrogen sulphide	Hard boiled egg	Yolk of hard boiled egg (1 g)
Sweaty	Conifer shrub (*Juniperus sabina*)	Soak 5 g leaves in 50 mL water for 24 h. Decant/filter and use liquid
Tar	Tar	Tar (5 g) in 23% ethanol for 24 h. Decant/filter and use liquid
Rubbery	Orange laboratory rubber pipe	Soak rubber pipe (5 g) in 23% ethanol for 24 h. Decant/filter and use liquid
Diesel	D Diesel	0,001%
Metallic	H&R Hydratrophic aldehydic dimethyl 1131183	0,001%
Plastic	Piece of soft plastic wrapping or plastic tubing	Place clear soft plastic (2 g) in water for 24 h. Decant/filter and use liquid

1 H&R = Haarmann & Reimer [Haarmann & Reimer (SA) (Pty) Ltd, 16 Milner Street, Metro Township, 7441 Milnerton]; B&F = Burgess & Finch essential oils [Burgess & Finch SA Distributors, P.O. Box 1175, Durbanville]; UF = Universal Flavours [Supplied by: In Essence, Suite 235, Private Bag X9, 2010 Benmore]; D = Dragoco [Dragoco South Africa (Pty) Ltd, 144 Boeing Road, East Elma Park, 1610 Edenvale]; and BDH [Distributed by: Merck (Pty) Ltd, P.O. Box 1998, 1685 Midrand].

2 Recommended concentrations. These concentrations may have to be adapted according to the sensitivity of the sensory panel.

3 Ethanol >95% (BDH 10107 6H).

4 Propane 1,2-diol (BDH 29673 6W).

international wine-tasting glasses (Vitria Glassware, Cape Town, South Africa) with a watch glass covering the opening. The use of blue tasting glasses ensured that the colour, or lack of colour, of the standards did not distract the evaluator. The watch glass over the opening contained the aroma in the glass and prevented aroma contamination of the tasting room.

Brandy Aroma Wheel Scorecard

Scorecards used for wine evaluation (Anon.; Crettenand, 1999), but incorporating the new brandy terminology, were compiled. The trained group of 21 people (discussed above) was used to evaluate the scorecards by using them during sensory sessions for evaluating commercial brandy samples.

RESULTS AND DISCUSSION

The Brandy Aroma Wheel includes brandy terminology currently in use, wine aroma terminology as well as new terminology specially selected during this study. As far as the authors could ascertain, no standardised English descriptive terminology for cognac had been published. Furthermore, South African brandy, while based on the same production process of cognac, often has a different aroma profile to cognac. For these reasons cognac terminology was not considered. A series of four brandy tastings, organised by the South African Brandy Foundation, also served as a platform where new descriptors could be generated and discussed.

The Brandy Aroma Wheel

The Brandy Aroma Wheel (Fig. 1) is a two-tier wheel with 18 first-tier descriptors and 75 second-tier descriptors. The first-tier descriptors give a broader description of an aroma, while the second-tier descriptors give a more precise definition. The descriptors are divided into positive and negative brandy-associated aromas. There are ten positive brandy aroma-associated first-tier descriptors, subdivided into 44 second-tier descriptors. The eight negative descriptors are in turn subdivided into 31 second tier descriptors. A Brandy Aroma Wheel with an identical format but incorporating Afrikaans terminology was also formulated (Afrikaans version not shown).

The descriptors are words most commonly used to describe brandy aroma. Many of these descriptors have specific meanings within a brandy context, which may be subtly different to their use in other industries. The terminology was developed to be applicable at all stages of brandy production and, consequently, only small sections of the listed descriptors are likely to be used at any one stage. Negative descriptors are also incorporated to describe faults that may occur during the production process.

The positive descriptors have been arranged in a progression from aromas that occur most commonly in young distillates ('smooth associated' and 'herbaceous') to more mature aromas ('sweet associated', 'nutty' and 'spicy'). However, as brandies are blended, they may have any make-up of aromas. The 'smooth associated' descriptor was chosen because certain aroma notes have historically become linked with the taste effects of mouth-feel. The descriptor 'smooth associated' therefore includes aroma notes that can be associated with the smooth mouth-feel and fullness of a brandy. The descriptor 'soapy' has no reference to soaps and detergents, but refers to a combination of C6, C8 and C10 esters. This anomaly originated as a company-specific descriptor that later found wider usage in the brandy industry. The 'herbaceous' aroma notes 'minty', 'eucalyptus' and 'buchu' relate to natural herbs and plants that are sometimes added to medicinal brandies and are not natural brandy-derived aromas. The 'fruity' aroma notes are arguably the most important in brandy and make it uniquely different and distinguishable from other distilled products such as the different kinds of whiskies and rum. The 'muscat' and 'floral' notes are found especially in brandies produced from aromatic Muscat grape types, e.g. Hanepoot grapes (Muscat d'Alexandrie). 'Woody' and 'toasted' notes are those derived during maturation from oak wood and prior treatment of the barrels, respectively. The 'nutty', 'sweet associated' and 'spices' aroma notes are often associated with especially 15- to 20-year-old brandies (Venter, 1994b).

Use of the wheel

The Brandy Aroma Wheel serves as an aid during brandy evaluation. It can be used in two ways. Firstly, the user may choose a principal term at the centre of the wheel. By working outwards a more precise description of the brandy aroma may be found. Alternately, he/she may find a descriptive term that comes spontaneously to mind when evaluating a brandy. This descriptor may then be "keyed-in" on the second tier. By working back to the centre of the wheel, the principal aroma category may be found. By linking each descriptive term to an intensity scale, an aroma profile of a brandy can be formulated. These profiles then form a picture of the aroma attributes of a brandy and illustrate how brandies differ from each other. Other terminology should preferably be excluded and synonyms in the wheel should rather be sought. It is also important that when the wheel is used analytically, the sensory panel members be trained to be familiar with the terminology and brandy aromas.

Reference standards

Reference standards were developed and linked to the descriptors (Table 1). They comprise natural extracts and nature-identical flavourants from flavour houses, pure chemicals, essential oils and whisky standards (Piggot, 1991). Compounds or formulations used for the standards are not necessarily found in brandy. They should, however, smell like brandy aroma nuances and be clearly linked to the descriptor. The exception was the standard for 'soapy' (discussed above). The reference standards should preferably be freshly prepared, although they can last approximately two weeks. It is, however, advisable that the panel leader or sensory analyst evaluate the condition of the standards before use and prepare fresh standards if required. The standards made from pure chemicals have a longer shelf life. In the case where no acceptable reference standard could be developed, i.e. 'lees oil', 'oily', 'cigar box/tobacco pouch', 'musty barrel' and 'musty cork', natural samples with that particular aroma note have to be sourced from the brandy industry.

The recommended concentrations are for a trained panel of individuals with an average sense of smell. However, it should be noted that most people (including experts) often have an 'aroma blindness' or are less sensitive to a particular aroma nuance. Should this be the case, the concentration of that particular standard should be increased accordingly. New, inexperienced panel members will also most likely require more concentrated standards (stronger smelling) until they have become familiar with the brandy aromas. The use of the standards will ensure that brandy judges have the same aroma frame of reference when judging brandy aroma.

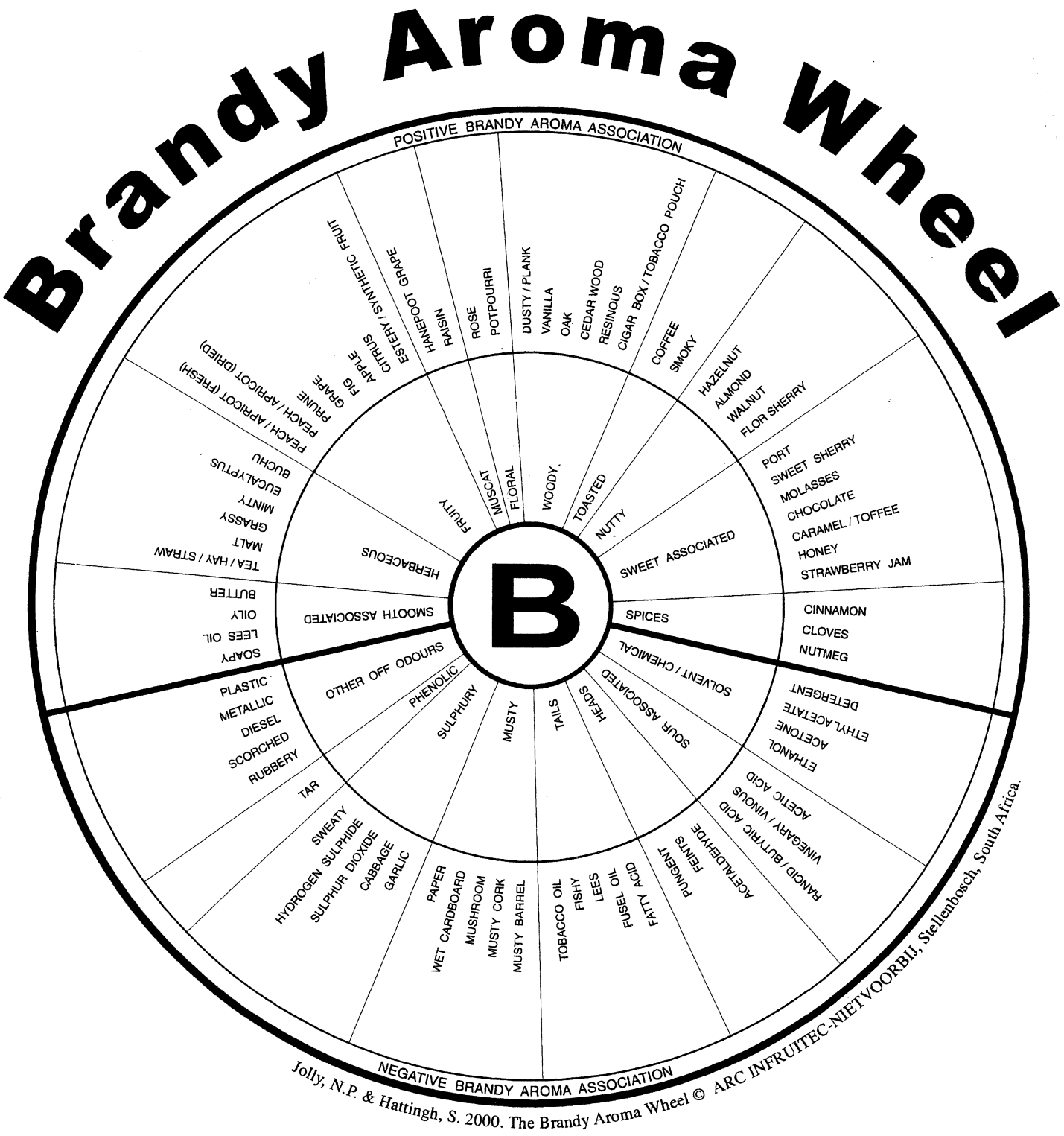

FIGURE 1
The Brandy Aroma Wheel showing first- and second-tier terms.

Brandy Aroma Scorecard

Two types of scorecards are suggested for use with the Brandy Aroma Wheel terminology. Both utilise first-tier descriptors from the Brandy Aroma Wheel. Only the descriptors relevant to the brandy being evaluated are incorporated. For example, the scorecard for a young distillate does not need the wood and aged aroma notes (Fig. 2). On this scorecard a judge can score a particular distillate aroma note on a structured scale of zero to five, where zero equals no aroma, one equals a slight/faint aroma and five equals a prominent aroma. The individual score is written in the space provided. The median of the individual judge's scores can subsequently be used to obtain an aroma profile of a brandy.

The second scorecard utilises an unstructured 10 cm line scale (Fig. 3), where intensity is indicated as 'undetectable' on the left-hand and 'prominent' on the right-hand end of the line. The judge indicates his or her score by making a mark on the line. The distance from the left of the line to the mark is measured and this value is used as the score. This scorecard facilitates statistical analysis, e.g. ANOVA, of data from a panel of judges. In both types of scorecard the descriptor 'other' can be utilised for aroma notes not listed. During data analysis, these aromas can be "keyed-in" by the sensory analyst or panel leader.

JUDGE:..... **DATE:**.....

Brandy Aroma Profile Scorecard

Give a mark for the different descriptive terms: 1 = faint aroma; 5 = prominent aroma.

No	Aroma Profile					
	Smooth ass.	Herba-ceous	Fruity	Floral	Solvent/ Chemical	Other (specify)
1						
2						
3						
4						
5						
6						

Jolly, N.P. & Hattingh, S. 2000. Brandy Aroma Profile Scorecard © ARC Infruitec-Nietvoorbij, South Africa.

FIGURE 2
A brandy aroma profile scorecard for the evaluation of a young distillate.

BRANDY AROMA SCORECARD

Judge: _____ Date: _____

Brandy no.: _____

Judge the aroma intensity of the brandy aroma nuances on the line scale.

NOSE (INTENSITY)

	Undetectable	Prominent
Smooth associated		
Herbaceous		
Fruity		
Flowery		
Other (Specify)		

Comments _____

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FIGURE 3
A brandy aroma scorecard for the evaluation of a young distillate.

CONCLUSIONS

The two-tiered Brandy Aroma Wheel was developed to provide standardised terminology for the evaluation of South African brandy. This terminology represents the most commonly used terms in the industry and the wheel is a representation of the knowledge of the experts in the industry. At the same time, the terminology is such that the consumer will also understand and be able to use the wheel. Furthermore, the Brandy Aroma Wheel together with the reference standards will enable the effective training of new brandy judges. The scorecards also facilitate the analysis of data generated by a panel of judges. However, as the English language is constantly developing and as new styles of brandy are developed, the Brandy Aroma Wheel will have to be revised to incorporate new terminology or remove obsolete terms.

LITERATURE CITED

Anonymous. Nietvoorbij wine-tasting sheets. ©Copyright. Wine Evaluation Committee, ARC Infruitec-Nietvoorbij, Private Bag X5026, 7599 Stellenbosch.

Aparico, R. & Morales, M.T., 1995. Sensory wheels: a statistical technique for comparing QDA panels – Application to Virgin Olive Oil. J. Sci. Food Agric. 67, 247-257.

Crettenand, J., 1999. Tasting cards in international wine competitions. In: Guimberteau, G. & Paetzold, M. (eds). Wine-tasting. Vigne et Vin Publications International, Bordeaux. pp. 99-106.

Guymon, J.F., 1974. The sensory character of brandy. Wines & Vines 55, 28-29.

Le Roux, J., 1997. Van Ryn – Advanced brandy course. Van Ryn Wine & Spirit Company, Stellenbosch.

Meilgaard, M.C., Dalgleish, C.E. & Clapperton J.F., 1979. Beer flavor terminology. J. Am. Soc. Brew. Chem. 37, 7-52.

Meilgaard, M.C., Reid, D.S. & Wyborski, K.A., 1982. Reference standards for beer flavor terminology system. J. Am. Soc. Brew. Chem. 40, 119-128.

Muir, D.D., Hunter, E.A., Williams, S.A.R. & Brennan, R.M., 1998. Sensory profiles of commercial fruit juice drinks: Influence of sweetener type. J. Sci. Food Agric. 77, 559-565.

Noble, A.C., Arnold, R.A., Masuda, B.M., Pecore, S.D., Schmidt, J.O. & Stern, P.M., 1984. Progress towards a standardized system of wine aroma terminology. Am. J. Enol. Vitic. 35, 107-109.

Noble, A.C, Arnold, R.A., Buechsenstein, J., Leach, E.J., Schmidt, J.O. & Stern, P.M., 1987. Modification of standardized system of wine aroma terminology. Am. J. Enol. Vitic. 38, 143-146.

Noble, A.C. & Howe, P.A., 1990. Sparkling Wine Aroma Wheel (Unpublished). ©Copyright. Noble, A.C. & Howe P.A., P.O. Box 1817, Healdsburg, CA 95448.

Piggot, J.R. & Jardine, S.P., 1979. Descriptive sensory analysis of whiskey flavour. J. Inst. Brew. 85, 82-85.

Piggot, J.R., 1991. Selection of terms for Descriptive Analysis. In: Lawless, H.T. & Klein, B.P. (eds). Sensory Science Theory and Applications in Foods. Marcel Dekker, Inc. New York. pp. 339-351.

Servili, M., Connor, J.M., Piggot, J.R., Withers, S.J. & Paterson, A., 1995. Sensory characterisation of virgin olive oil and relationship with headspace composition. J. Sci. Food Agric. 67, 61-70.

Shortreed, G.W., Rickards, P., Swan, J.S. & Burtles, S., 1979. The flavour terminology of Scotch Whisky. Brewer's Guardian, November.

Venter, W.P., 1994a. Faktore wat brandewynveroudering beïnvloed en die belangrikste reaksies wat daartydens plaasvind. Wynboer Tegnies 62, 12-14.

Venter, W.P., 1994b. Die sintuiglike beoordeling van potketelbrandewyn. Wynboer Tegnies 65, 10-12.

Williams, A.A., 1975. The development of a vocabulary and profile assessment method for evaluating the flavour contribution of cider and perry aroma constituents. J. Sci. Food Agric. 26, 67-582.