

A SCREENING TEST FOR FIELD AND RESIDENT ODOR ASSESSORS

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ABSTRACT

Resident odor assessors are often sought for monitoring the odor occurrence in the community. Recruited assessors are regularly asked to rate or describe several odor parameters, such as intensity, duration, offensiveness, and odor character. Optimally, these people would reflect the average odor perception of that specific community. Selection of people based on their 1-butanol threshold, using a dynamic olfactometer, may not be a viable approach since an olfactometry laboratory is not always available nearby. Moreover, the kinds of reports made by resident assessors require other qualities beyond presenting 1-butanol threshold within a specific range.

In this study we developed a screening test for field and resident odor assessors. The test includes three main parts: A triangular forced-choice test, odor intensity evaluation, hedonic tone and odor character evaluation. Grading was based on two criteria: 1. providing correct answers in the relevant parts of the test, 2. describing odor intensity, hedonic tone and odor character in a way similar to the average odor perception of that specific population. This was done by first averaging the results of the tested population and then grading each result based on its distance from the average.

A group of 144 individuals (83 women and 61 men) participated in this study. Of them, 18 were in an age between 21-30; 44 between 31-40; 37 between 41-50; 39 between 51-60; and 6 individuals between 61 and 70. The average final grade of this population was 86.6 (± 9.12) and the median was 88.0. It was decided that individuals whose final grade was within the upper 75th percentiles (final grade ≥ 80.38) would pass the test. A 72.3% out of the men and 78.7% out of the women passed the test. A 78.8% out of the people living in cities passed the test but only 69.5% out of the people living in rural settlements. Age played a substantial factor mainly in the age groups over 51 years old. At the first three age groups (between 21-50) about 80% passed the test, whereas only 66.7% and 33.3% passed the test in the 51-60 and 61-70 age groups, respectively.

This proposed test and grading procedure found useful by us to screen for assessors with good smelling capability and with relatively average odor perception. The test is very simple to perform, does not need any special laboratory and is especially suitable to recruit resident assessors within the community.

KEYWORDS

Odor test, odor assessors, intensity scale, odor perception, hedonic tone, 1-butanol

INTRODUCTION

Odor assessors are frequently used by environmental authorities and were also incorporated in odor studies (e.g. Both *et al.*, 2004; Guo *et al.*, 2005a, 2005b). The nuisance and health concerns caused by odors from industrial and livestock facilities are among the key issues that affect the neighboring communities. In cases of continues multiple odor complaints from a community, there might be a need to recruit local residents who are able to assess odor parameters such as intensity, duration, offensiveness, hedonic tone and odor character.

Individuals who are most appropriate to serve as odor assessors seem to be those people who reflect the average odor perception of that specific community. In such cases the standard 1-butanol detection threshold may not be sufficient. Moreover, an olfactometry laboratory is not always available nearby. In this manuscript we present a testing procedure which was adopted by the Israel Ministry of Environmental Protection and the Ministry of Agriculture in order to recruit field and resident odor assessors.

METHODOLOGY

The odor test includes three main parts (Fig. 2):

Part 1 - A triangular forced-choice test

This part of the test composes of 5 series, each contains 3 solutions, 2 of them are identical. The assessor is asked to select the odd solution out of three (Figure 1; left):

Set I: One solution of *p*-cresol, two solutions of 1-butanol.

Set II: One solution of 1-butanol, two solutions of *p*-cresol.

Set III: One solution of limonene, two solutions of *p*-cresol.

Set IV: One solution of 1-butanol, two solutions of limonene.

Set V: One solution of limonene, two solutions of 1-butanol.

The aqueous concentrations of the solutions in this part of the test are the following: *p*-cresol, 250 mg/l; 1-butanol, 2,000 ppm and limonene, 200 ppm. The solutions are freshly prepared with deionized water a day before the test. A 60 ml are placed in each 100 ml wide-mouth glass bottle.

The assessor is asked to rest for 10 minutes before he is introduced to the second part of the test.

Part 2 - Odor intensity evaluation

2A: A 10-point static scale is prepared with 1-butanol in deionized water (Figure 1; right). The aqueous 1-butanol concentrations are the following: 125, 250, 500, 1,000, 2,000, 4,000, 8,000,

16,000, 32,000, and 64,000 ppm. One of the bottles is removed from the series (the 4th, 5th or the 6th bottle). The remaining bottles are bundle together into one row. The test administrator asks the assessor to place the removed bottle back in its right position (between two bottles).

2B: The assessor is asked to describe the odor intensity of all bottles on a scale from 0 to 6, where 0=no odor, 1=very faint, 2=faint, 3=moderate, 4=strong, 5=very strong, and 6=irresistible (the assessor uses the descriptive words and the test administrator translates these words to their corresponding intensity numbers).

Part 3 – Hedonic tone and odor character

3A: The assessor is asked to evaluate the hedonic tone of two 1-butanol solutions from the 10-point static scale, using a scale from -4 to +4. The test administrator usually selects one "weak" solution and one "strong" solution for this part, based on the descriptions made by this individual in Part 2B).

3B: The assessor is asked to evaluate the hedonic tone and odor character of four aqueous solutions: *p*-cresol (500 mg/l), limonene (400 ppm), butanoic acid (400 ppm) and 1-butanol (16,000 ppm). The odor character is described by selecting descriptive words from the following list: 1. chemicals or solvents, 2. pungent, 3. offensive, 4. unpleasant, 5. medicinal, 6. citrus, 7. pleasant, 8. perfume, 9. herbal, 10. other.



Figure 1. *Left:* A triangular forced-choice test (actual tests are performed with wide-mouth glass bottles). *Right:* Odor intensity evaluation.

Grading procedure

The purpose of this test is to select for individuals who have good smelling capability on one hand and whose odor perception reflects the average odor perception by the population in Israel, on the other hand. For that, grading was based on two criteria: **1.** providing the correct answer in the relevant parts of the test (the triangular forced-choice test and locating the removed 1-butanol solution back to the right position in the 10-points static scale); **2.** describing odor intensity,

hedonic tone and odor character in a way similar to the average odor perception of that specific population. This was done by first averaging the results of the tested population and then grading each result based on its distance from the average.

A 70% of the total grade was given to the first criteria. This included part 1 (40%) and part 2A (30%). A 30% of the total grade was given to the second criteria. This included parts 2B (12%), and part 3 (18%). More details on the grading procedure are given in Table 1.

Table 1. Grading procedure (see example in Fig. 2)

Test part	Grading
Part 1	8 points for each correct answer (5 series). Maximum: 40 points.
Part 2A	30 points for correct answer. 8 points are taken for one incorrect position; 16 points are taken for two incorrect positions; etc. Maximum 30 points.
Part 2B	The average of the tested population (144 individuals) for each 1-butanol concentration is determined first. Then, for every individual, the distances from the average values for each solution are summarized. The final grading is as follows: 12 points are given if the sum of distances is between 0-2.5; 11 points if it is between 2.5-5; 9 points if between 5-7.5; 6 points if between 7.5-10; and 2 points if it is between 10-12.5. Maximum 12 points.
Part 3A	The average of the tested population (144 individuals) for the two selected 1-butanol solutions is determined first. Then, for every individual, the distances from the average values for these two solutions are summarized. The final grading is as follows: 7 points are given if the sum of distances is between 0-2.5; 6 points if it is between 2.5-5; 4 points if between 5-7.5; and 1 point if between 7.5-10. Maximum 7 points.
Part 3B	<u>Hedonic tone:</u> The average of the tested population (144 individuals) for each odor type is determined first. Then, for every individual, the distances from the average values for each solution are summarized. The final grading is as follows: 7 points are given if the sum of distances is between 0-2.5; 6 points if between 2.5-5; 4 points if between 5-7.5; and 1 point if between 7.5-10. Maximum 7 points. <u>Odor character:</u> The most frequent descriptions selected by the tested population (144 individuals) for each solution is determined first. For each solution, 1 point is given if the assessor uses one of the most frequent descriptions; 0.5 point if he uses one of the less frequent descriptions; and no point is given if he uses a non-frequent description. Maximum 4 points (1 point for each solution).
TOTAL	100 points

Odor test

Date of test:										
Personal details										
First name:					Last name:					
Gender : [M] [F]				Age:						
Address:							ID Number:			
Workplace:										
Position:										
Phone (H):				Phone (Mobile):				Phone (W):		
PART 1 – Forced Choice (Mark the odd bottle)										
		I	1	2	3					
		II	4	5	6					
		III	7	8	9					
		IV	10	11	12					
		V	13	14	15					
PART 2 – Odor intensity										
2a. Place the bottle in the right position										
Bottle No.	1	2	3	4	5	6	7	8	9	10
Removed bottle No.	Answer									
2b. Determine odor intensity for each bottle										
Bottle No.	1	2	3	4	5	6	7	8	9	10
Intensity										
Intensity: 0=no odor, 1=very faint, 2=faint, 3=moderate, 4=strong, 5=very strong, 6=irresistible										
PART 3 – Hedonic tone and odor character										
<u>Hedonic tone scale</u>										
most unpleasant -4 -3 -2 -1 0 +1 +2 +3 +4 most pleasant										
3a. Determine the hedonic tone of selected bottles from the intensity series										
Bottle No.	1	2	3	4	5	6	7	8	9	10
Hedonic tone										
3b. Determine hedonic tone and odor character										
Bottle No.	1	2	3	4	Odor character: 1=Chemical/solvent, 2=Pungent, 3=Offensive, 4=Unpleasant, 5=Medicinal, 6=Citrus, 7=Pleasant, 8=Perfume, 9=Herbal, 10=Other					
Hedonic tone										
Odor character										
Assessor signature _____					Test administrator signature _____					

Odor test

85
100

Passed

Date of test: . May 2, 2007											
Personal details											
First name: Yosef					Last name: Cohen						
Gender: <input checked="" type="checkbox"/> [M] <input type="checkbox"/> [F]			Age: 37								
Address: 7 Goldman St. Haifa							ID Number: 05 8852831				
Workplace: Ministry of Environmental Protection											
Position: Inspector											
Phone (H): 04-8341175			Phone (Mobile): 050 6223177				Phone (W): 04-8117781				
PART 1 – Forced Choice (Mark the odd bottle)											
	I	1	<input checked="" type="checkbox"/> 2	3	✓						
	II	4	5	<input checked="" type="checkbox"/> 6	✓						
	III	<input checked="" type="checkbox"/> 7	8	9	✓						
	IV	10	11	<input checked="" type="checkbox"/> 12	✓						
	V	13	<input checked="" type="checkbox"/> 14	15	✓						
										40 40	
PART 2 – Odor intensity											
2a. Place the bottle in the right position											
	Bottle No.	1	2	3	<input checked="" type="checkbox"/> 4	5	6	7	8	9	10
Removed bottle No.	5	Answer									
2b. Determine odor intensity for each bottle											
	Bottle No.	1	2	3	4	5	6	7	8	9	10
	Intensity	Weak	Weak	moderate	moderate	moderate	moderate	strong	strong	very strong	irresistible
Intensity: 0=no odor, 1=very faint, 2=faint, 3=moderate, 4=strong, 5=very strong, 6=irresistible											
PART 3 – Hedonic tone and odor character											
<u>Hedonic tone scale</u>											
	most unpleasant	-4	-3	-2	-1	0	+1	+2	+3	+4	most pleasant
3a. Determine the hedonic tone of selected bottles from the intensity series											
	Bottle No.	1	2	3	4	5	6	7	8	9	10
	Hedonic tone			-2				-3			
3b. Determine hedonic tone and odor character											
	Bottle No.	1	2	3	4	Odor character:					
	Hedonic tone	4	-4	-3	1	1=Chemical/solvent, 2=Pungent, 3=Offensive, 4=Unpleasant, 5=Medicinal, 6=Citrus, 7=Pleasant, 8=Perfume, 9=Herbal, 10=Other					
	Odor character	6	3	1	1						
Assessor signature <u>Yosi</u>					Test administrator signature <u>R</u>						

22
30

9
12

6
7

4
7

4
7

Figure 2. *Top:* Blank Test Form; *Bottom:* Example Completed Test Form. As detailed in Table 1, the grades for Part 1 and Part 2A are based on correct or incorrect answers, while the grades for the other parts are based on how an individual perceives the odor relatively to the tested population. In this example, 3 points were taken in Part 2B because the odor intensity for some of the solutions was described fairly different than the average population. The assessor described bottle#1 and 2 as "weak (faint)" odor ("2" on the intensity scale) whereas the average intensity was 0.62 and 1.07, for bottle#1 and 2, respectively. Similarly, in Part 3B the assessor described the hedonic tone of the second solution as "-4" whereas the average value was -1.81 only.

The tested population

A group of 144 individuals participated in this study, 61 (42.4%) women and 83 (57.6%) men. Of them, 18 individuals were in an age between 21-30; 44 between 31-40; 37 between 41-50; 39 between 51-60; and 6 individuals between 61 and 70 (Figure 3). A 59.0% lived in cities whereas 41.0% lived in rural settlements. People who reported about temporary health problems (flue-like symptoms) did not participated in the test.

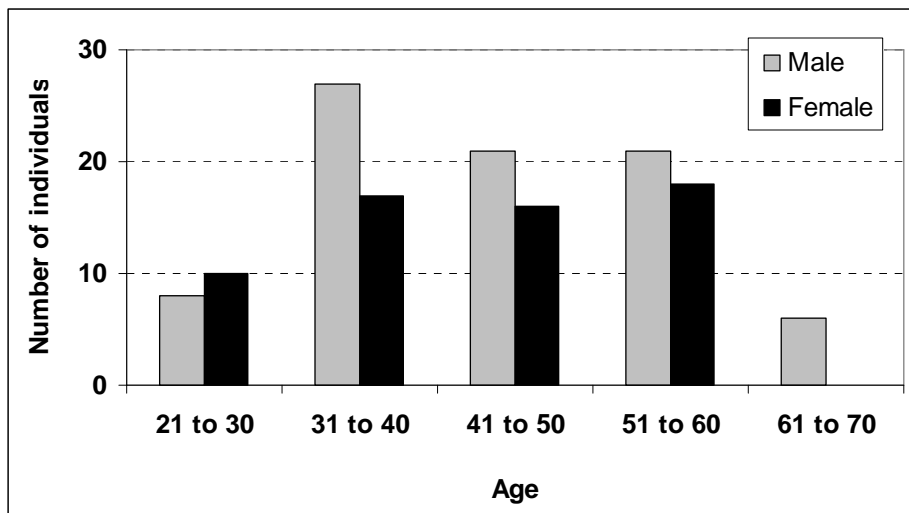


Figure 3. Age distribution of the tested population (total 144 individuals).

RESULTS AND DISCUSSION

Some of the test results are presented below:

Triangular forced-choice test (Part 1)

A 52.8% of the tested population made correct answers for all 5 series. A 30.6% made one mistake and 13.2% made 2 mistakes. No substantial differences were found between male and female (Figure 4).

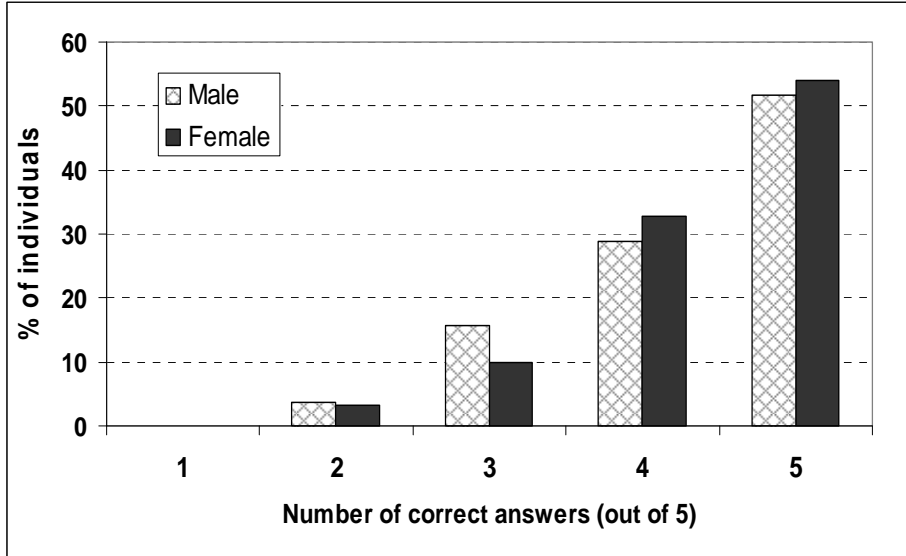


Figure 4. Distribution of correct answers in the triangular forced-choice test.

The highest number of mistakes was made in the second series (Figure 5). Only 70.8% of the tested population made a correct answer for this series, whereas about 85-90% made correct answers for all other series. This seems to result from the order of the series. The first two series were composed of same solutions: Series I was composed of one solution of *p*-cresol and two solutions of 1-butanol, whereas series II was composed of one solution of 1-butanol and two solutions of *p*-cresol. The third series had limonene which has a completely different odor, thus "refreshing" the olfactory system.

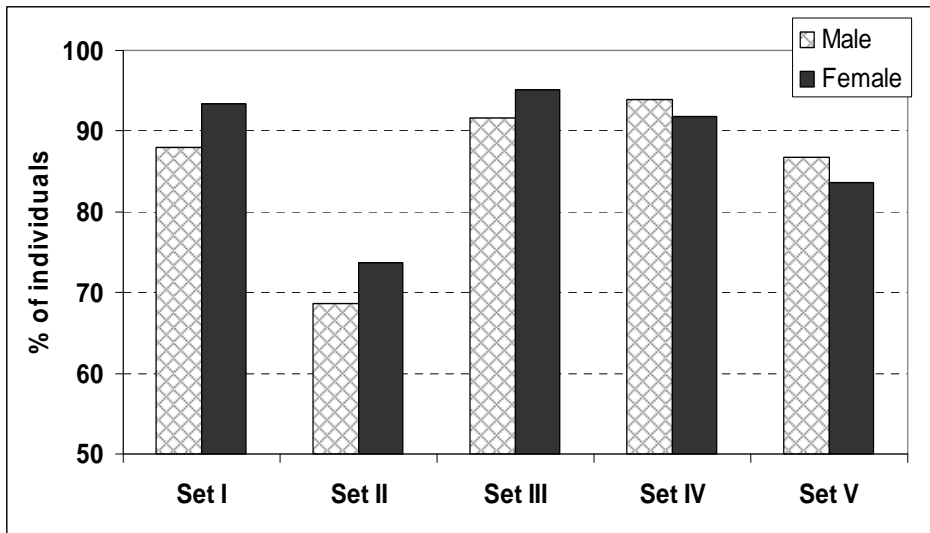


Figure 5. Distribution of correct answers among series.

Intensity series (Part 2B)

The results of the 10-points series are presented in Figure 6. Linear relationships were obtained for log 1-butanol concentration vs. the odor intensity scale. No substantial differences were obtained between male and female. The error bars represent the variation within the tested population. As explained above, full grading is given to results that are most close to the average intensity reported by the tested population.

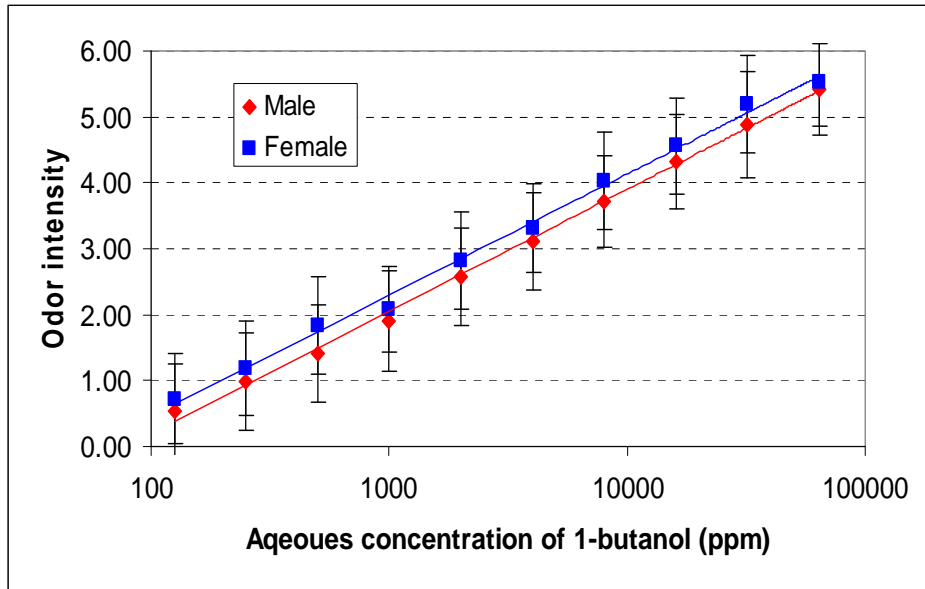


Figure 6. Odor intensity of a 10-point static scale of 1-butanol.

Final grades

A critical part of this screening procedure is to determine the minimum grade that is required to pass the test (i.e. that this individual can be certified as an odor assessor). The average final grade of this population was 86.6 (± 9.12) and the median was 88.0. It was decided that those assessors whose final grade was within the upper 75th percentiles (final grade ≥ 80.4) would pass this test (Figure 7). It is important to note that the decision to certify the upper 75th percentile is "managerial" and should be adopted with criticism.

A 72.3% out of the men and 78.7% out of the women passed the test. A 78.8% out of the people living in cities passed the test but only 69.5% out of the people living in rural settlements. Age played a substantial factor mainly in the age groups over 51 years old. At the first three age groups (between 21-50) about 80% passed the test, whereas only 66.7% and 33.3% passed the test in the 51-60 and 61-70 age groups, respectively.

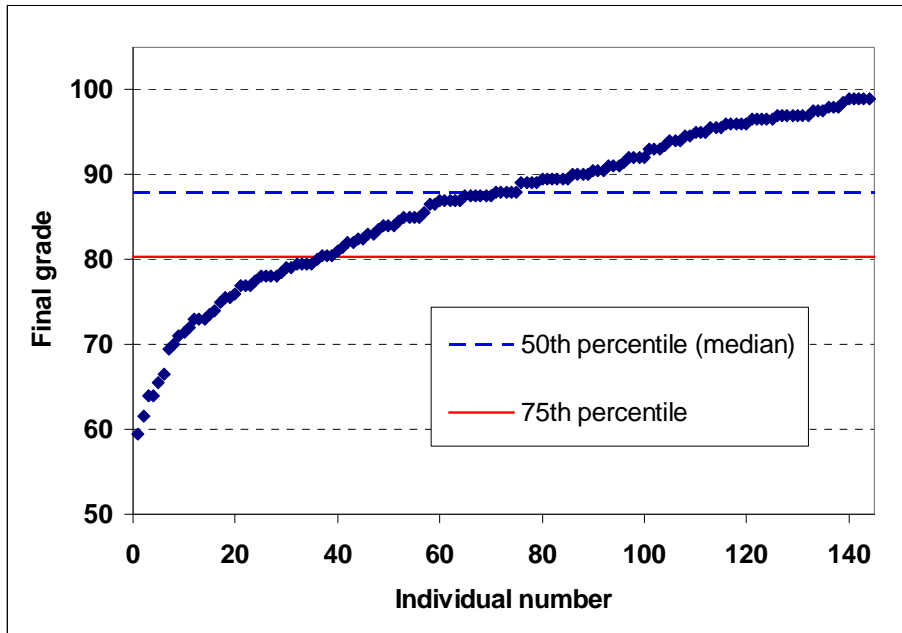


Figure 7. Final grades of the tested population in an ascending order.

SUMMARY AND CONCLUSIONS

An odor test and grading procedure were developed as a screening test for field and resident odor assessors. The test includes three main parts: A triangular forced-choice test, odor intensity evaluation, hedonic tone and odor character evaluation. Grading is based on two criteria: 1. providing correct answers in the relevant parts of the test; and 2. describing odor intensity, hedonic tone and odor character in a way similar to the average odor perception of that specific population.

Based on the results obtained for a group of 144 individuals, we propose that the test and the grading procedure are useful to screen for assessors with good smelling capability and with relatively average odor perception. The test is very simple to perform, does not need any special laboratory and is especially suitable to recruit resident assessors within the community.

This screening procedure developed in this study may become helpful for regulatory purposes. The Israeli Prevention of Nuisance Law, 5721-1961 (the Kanowitz Law), Clause 3, Odor Prevention, states “*No individual will cause an **intense or unreasonable odor**, from any source, which disturbs, or might disturb an individual nearby or disturb passersby*”. Unfortunately, the terms “**intense**” (**strong**) or “**unreasonable**” are not well defined such that law enforcement is often problematic. In this study, among the individuals who passed the test (108 out of 144), 63.9% of them described bottle#7 in the 1-butanol series (8,000 ppm) at least as “**strong**” odor and over 90% of them described the rest of the bottles in this series at least as “strong”. It implies that a team of certified odor assessors (4 individuals) who reports “strong odor” seem to reflect

the "average odor intensity perception" of the community. In fact, no special training is needed for these certified teams. Their natural odor perception must be sufficient to indicate violation of the Odor Prevention Law.

ACKNOWLEDGMENTS

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