

Report

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# Comparative study pH-Fix test strips

## 1. Summary / Abstract

In the following study, the pH-Fix 0-14 test strips from MACHEREY-NAGEL (REF 92110) and the MQuant®\* pH 0-14 test strips from Merck\* (REF 1.09535.0001) were tested for their usability and compared with each other. The subjects (with and without laboratory experience) carried out comparative tests with buffer solutions and evaluated the design, handling and general user-friendliness of the product. After evaluating the results, the test subjects were able to correctly reproduce the pH value of the test solutions with the product pH-Fix 0-14 test strips (MN) with a rate of 88 %. For the MQuant®\* pH 0-14 test strips (Merck\*), this rate was 80 %. The usability of the pH-Fix 0-14 test strips (MN) averaged 4.65 (scale 1 (very poor) - 5 (very good)). The MQuant®\* pH 0-14 test strips (Merck\*) scored an average of 4.09.

## 2. Study design

In this usability study, two non-bleeding pH test strips of different brands were compared. In addition to the accuracy of the pH value, the test subjects also compared other factors such as the design and comprehensibility of the instructions for use. The study details can be found in the following chapters.

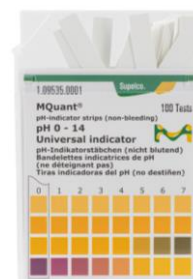
### 2.1. Question

The aim of the study was to highlight the comparability of the two test strips pH-Fix 0-14 (MN) and MQuant®\* pH 0-14 (Merck\*). In addition to the exact and correct determination of pH values, the usability of the two products should also be compared.

### 2.2. Products

The following products were compared:

Product	pH fix 0-14	MQuant®* pH 0-14
Company	MACHEREY-NAGEL	Merck*
Item number	REF 92110	REF 1.09535.0001
LOT	10D0121	HC151257



### 2.3. Subjects

15 (w = 8, m = 7) persons between the age of 20 and 50 years were selected as test subjects. 4 of the 15 participants already had laboratory experience in determining the pH value of buffer solutions with pH test strips while 11 of the 15 persons were without laboratory experience.

Subjects	Quantity
N (number of subjects)	15
Gender (f/m)	8/7
Without/with laboratory experience	11/4

### 2.4. Comparison of the pH value determination

In the first sub-study, the subjects had to determine the pH of 15 unknown buffer solutions using the two comparison products. Titrisol® buffers from Merck\* were used for the standard solutions (with the exception of 0,1,13 and 14). The stock solutions with a pH of 0.1,13 and 14 were prepared using 1 M hydrochloric acid, 0.1 M hydrochloric acid, 0.1 M sodium hydroxide solution and 1 M sodium hydroxide solution.

All pH values between 0-14 were prepared in increments of 1 and measured blindly in different sequences. The subjects had to note down the pH value after each determination of a buffer solution.

### 2.5. Usability

After carrying out the pH value determinations, the subjects were given a usability questionnaire. They had to answer the following questions and rate them with a number between 1 (very poor) - 5 (very good):

- Is the experimental procedure clearly described on the plug-in box?
- Is it clear how long the test strips are to be used?
- Was the removal of the test strip practical?
- Only for pH-Fix 0-14 (MN): Do you see an advantage in removing the test strips through the "smart corner"?
- Does the test strip length agree with you when dipping into the sample?
- Is stopping the test strip at the comparison scale clearly understandable?
- Could the corresponding pH value of the sample be easily determined by comparing the color of the test patches with the color scale?
- Did the division and the colors of the color scale allow a simple assessment of the pH value?
- Were you able to complete testing without help from others?
- Would you rate the use of the test strip as unproblematic?
- Is the use of the test strip intuitive and easy to understand?
- Did the test strip meet your expectations?

In addition, the following three final questions were asked without a possible numerical score:

- What did you like about the test strip?
- What can be improved about the test strip or the packaging?
- Have you had any negative experiences with the use of the test strips?

### 3. Results

#### 3.1. Comparison of pH value determination - pH-Fix 0-14 (MN)

Table 1 shows the results of the pH value determinations of the pH-Fix 0-14 test strips from MACHEREY-NAGEL. In this cross diagram, the correctly read pH values are marked in green. Deviations of +/- 1 pH value are marked in yellow. Deviations of more than one pH value are highlighted in red:

Total	Target pH value														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Measured pH value	0	9	10	-	-	-	-	-	-	-	-	-	-	-	-
	1	6	5	1	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	14	-	-	-	-	-	-	-	-	-	-	-
	3	-	-	-	15	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	15	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	15	-	-	-	-	-	-	-	-
	6	-	-	-	-	-	-	15	-	-	-	-	-	-	-
	7	-	-	-	-	-	-	-	15	-	-	-	-	-	-
	8	-	-	-	-	-	-	-	-	15	-	-	-	-	-
	9	-	-	-	-	-	-	-	-	-	15	-	-	-	-
	10	-	-	-	-	-	-	-	-	-	-	15	-	1	-
	11	-	-	-	-	-	-	-	-	-	-	-	14	2	-
	12	-	-	-	-	-	-	-	-	-	-	-	1	12	1
	13	-	-	-	-	-	-	-	-	-	-	-	-	-	9
	14	-	-	-	-	-	-	-	-	-	-	-	-	-	5

Table 2: Comparison of the nominal and actual pH values determinations with the test strips pH-Fix 0-14 from MACHEREY-NAGEL.

#### 3.2. Comparison of pH value determination - MQuant®\* pH 0-14 (Merck\*)

In Table 3, the results of the pH value determinations of the MQuant®\* pH 0-14 test strips from Merck\* are plotted. In this cross diagram, the correctly read pH values are marked in green. Deviations of +/- 1 pH value are marked in yellow. Deviations of more than one pH value are highlighted in red:

Total	Target pH value															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Measured pH value	0	12	-	1	-	-	-	-	-	-	-	-	-	-	-	
	1	3	12	2	-	-	-	-	-	-	-	-	-	-	-	
	2	-	2	12	-	-	-	-	-	-	-	-	-	-	-	
	3	-	-	-	15	-	1	-	-	-	-	-	-	-	-	
	4	-	-	-	-	14	-	-	-	-	-	-	-	-	-	
	5	-	-	-	-	-	12	-	-	-	-	-	-	-	-	
	6	-	-	-	-	-	2	14	5	-	-	-	-	1	-	
	7	-	-	-	-	-	-	1	10	9	-	-	1	-	-	
	8	-	-	-	-	1	-	-	-	7	-	-	-	-	-	
	9	-	-	-	-	-	-	-	-	-	10	1	-	-	-	
	10	-	-	-	-	-	-	-	-	-	5	12	1	-	-	
	11	-	-	-	-	-	-	-	-	-	-	2	11	-	-	
	12	-	-	-	-	-	-	-	-	-	-	-	2	14	-	
	13	-	-	-	-	-	-	-	-	-	-	-	-	-	14	6
	14	-	-	-	-	-	-	-	-	-	-	-	-	-	1	9

Table 4: Comparison of the nominal and actual pH values determinations with Merck\*'s MQuant®\* pH 0-14 test strips.

### 3.3. Comparison of pH value determination - pH-Fix 0-14 (MN) vs. MQuant®\* pH 0-14 (Merck\*)

The correctly determined pH values of the two different pH test strips described above were set in the ratio of all comparative measurements performed and expressed in % (Table 5):

Product	pH-Fix 0-14 (MN)	MQuant®* pH 0-14 (Merck*)
Total number of measurements (m)	225	225
Correctly determined values (m <sub>k</sub> )	198	180
<b>Correctness (m<sub>k</sub>/m x 100)</b>	<b>88 %</b>	<b>80 %</b>

Table 6: Comparison of the correct pH value determinations with the test strips pH-Fix 0-14 (MN) and MQuant®\* pH 0-14 (Merck\*).

### 3.4. Comparison of serviceability - pH-Fix 0-14 (MN)

When comparing the usability, the pH-Fix 0-14 test strips scored an average of 4.65 (scale (very poor) - 5 (very good)) (see Table 4). Furthermore, it became apparent that users lack a clear indication of the immersion time.<sup>1</sup> Not all subjects saw the use of the "clever corner" for easier removal and closing of the product as an advantage or disadvantage. Most subjects agreed that the pH values 0 and 1 were very difficult to distinguish. This was also evident in the objective pH study (see Table 1). The ratings and comments on the questions asked can be seen below (Table 7):

<sup>1</sup> MACHEREY-NAGEL has subsequently included the immersion time on your product based on the results of this study.

Question	Scale	Comments
Is the experimental procedure clearly described on the plug-in box?	4,61	Immersion time not clearly defined
Is it clear how long the test strips are to be used?	4,50	
Was the removal of the test strip practical?	4,50	
Do you see an advantage in removing the test strips through the "smart corner"?	4,15	More practical when removing than when closing
Does the test strip length agree with you when dipping into the sample?	4,85	
Is stopping the test strip at the comparison scale clearly understandable?	4,62	Reading direction not directly clear
Could the corresponding pH value of the sample be easily determined by comparing the color of the test patches with the color scale?	4,38	
Did the division and the colors of the color scale allow a simple assessment of the pH value?	4,38	Differentiation pH 0 and pH 1 difficult
Were you able to complete the testing without help from others?	4,92	Differentiation pH 0 and pH 1 difficult
Would you rate the use of the test strip as unproblematic?	4,85	
Is the use of the test strip intuitive and easy to understand?	5,00	
Did the test strip meet your expectations?	5,00	
<b>Overall score</b>	<b>4,65</b>	

Table 8: Results of the usability questionnaires of pH-Fix 0-14 (MN).

For the final three non-rated questions, the following comments were made by the subjects:

What did you like about the test strip?

- Simple and fast
- Brilliant colors
- The smart corner
- Reading direction of the test strip compared to the packaging
- Test strip length
- Clear design
- Simple assignment

What can be improved about the test strip or the packaging?

- Exact specification of the immersion time<sup>1</sup>
- Improve difference pH 0 and pH 1
- Closing with one hand / smaller opening

Have you had any negative experiences with the use of the test strips?

- Difference pH 0 and pH 1 not well visible

3.5. Comparison of fitness for use - MQuant<sup>®</sup>\* pH 0-14 (Merck\*)

When comparing usability, the MQuant<sup>®</sup>\* pH 0-14 test strips scored an average of 4.09 (scale (very poor) - 5 (very good)) (see Table 5). In addition to a clearer pictogram as a more intuitive guide, users lacked the presence of a best-before date. Furthermore, the test strip appeared too short and unwieldy, especially for large hands. The reading direction on the scale also proved to be impractical, since on the one hand the product packaging is thus heavily contaminated with the solution, and on the other hand the reading direction appeared to the users to be "the wrong way round". Furthermore, the color differentiation at pH 6 - 8 was not clear enough (see also Table 2). Below you will find the evaluation and comments on the questions asked (Table 9):

Question	Scale	Comments
Is the experimental procedure clearly described on the plug-in box?	4,29	Instructions not intuitively recognizable
Is it clear how long the test strips are to be used?	2,79	No MHD available
Was the removal of the test strip practical?	3,43	Difficulties with wide fingers
Does the test strip length agree with you when dipping into the sample?	3,54	Test strip too short
Is stopping the test strip at the comparison scale clearly understandable?	4,23	Alignment of the scale not practical
Could the corresponding pH value of the sample be easily determined by comparing the color of the test patches with the color scale?	3,85	Difficulties at pH 6 - 8
Did the division and the colors of the color scale allow a simple assessment of the pH value?	3,96	
Were you able to complete the testing without help from others?	5,00	
Would you rate the use of the test strip as unproblematic?	4,31	
Is the use of the test strip intuitive and easy to understand?	4,65	
Did the test strip meet your expectations?	4,92	
<b>Overall score</b>	<b>4,09</b>	

Table 10: Results of the usability questionnaires of MQuant<sup>®</sup>\* pH 0-14 (Merck\*).

For the final three non-rated questions, the following comments were made by the subjects:

What did you like about the test strip?

- Immersion time is defined
- Test strip markings on scale
- "One-hand" handling
- Opens easily
- Small and handy

What can be improved about the test strip or the packaging?

- Test strip too short
- No best before date available
- Too much text on the packaging
- No clear design
- Reading direction not intuitive
- Opening too small for large hands

Have you had any negative experiences with the use of the test strips?

- Too many test strips taken at once, as opening too small
- Difference pH 6 - 8 not well evident

### 3.6. Comparison of fitness for use - pH-Fix 0-14 (MN) vs. MQuant®\* pH 0-14 (Merck\*)

The average usability scores determined in Chapters 3.4 and 3.5 show that MACHEREY-NAGEL's pH-Fix 0-14 test strips performed better than Merck\*'s MQuant®\* pH 0-14 with an average score of 4.65 compared to 4.09 (Table 11):

Product	pH-Fix 0-14 (MN)	MQuant®* pH 0-14 (Merck*)
Average score (scale 1 to 5)	4,65	4,09

Table 12: Comparison of the test strip usability of pH-Fix 0-14 (MN) and MQuant®\* pH 0-14 (Merck\*).

## 4. Result

This comparative study shows that the pH test strips pH-Fix 0-14 from MACHEREY-NAGEL compared with MQuant®\* pH 0-14 from Merck\* performs better in both, the correct pH determination (see chapter 3.3) of buffer solutions and in subjective user-friendliness (see chapter 3.6).

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