A decorative border with intricate floral and leaf patterns surrounds the text. The border consists of repeating motifs of leaves and flowers, creating a classic, elegant frame.

*A Test of the
inhibiting properties of lemonjuice
in
henna color development*

Henna Test performed in Berlin, May 2006.

Testing done by

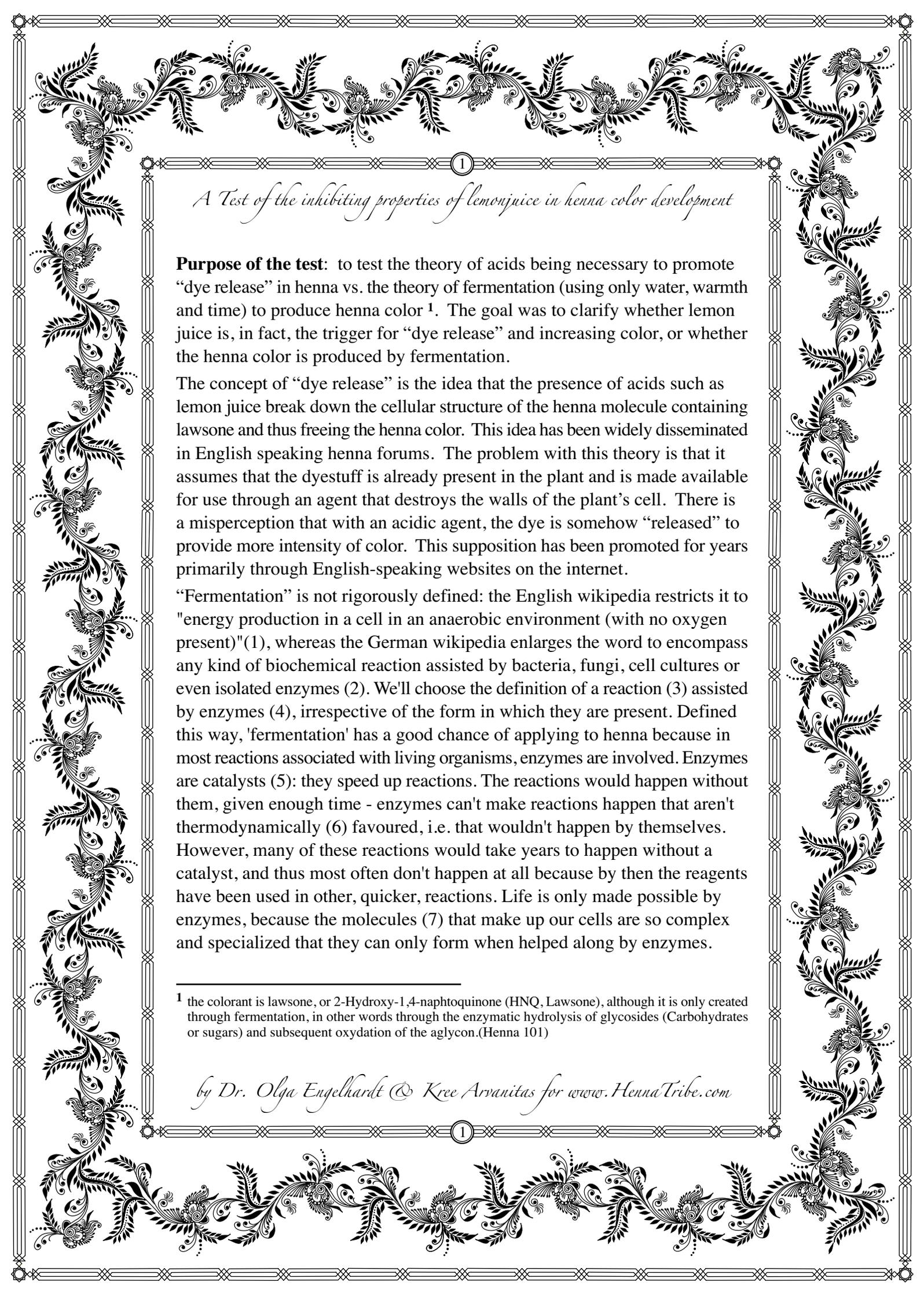
Dr. Olga Engelhardt,

Anne Kirkham and Kree Arvanitas.

Report by Dr. Olga Engelhardt,

Edited by Kree Arvanitas

© 2007 www.HennaTribe.com

A decorative border with intricate floral and leaf patterns surrounds the text. At the top center of the border is a small circle containing the number 1.

A Test of the inhibiting properties of lemonjuice in henna color development

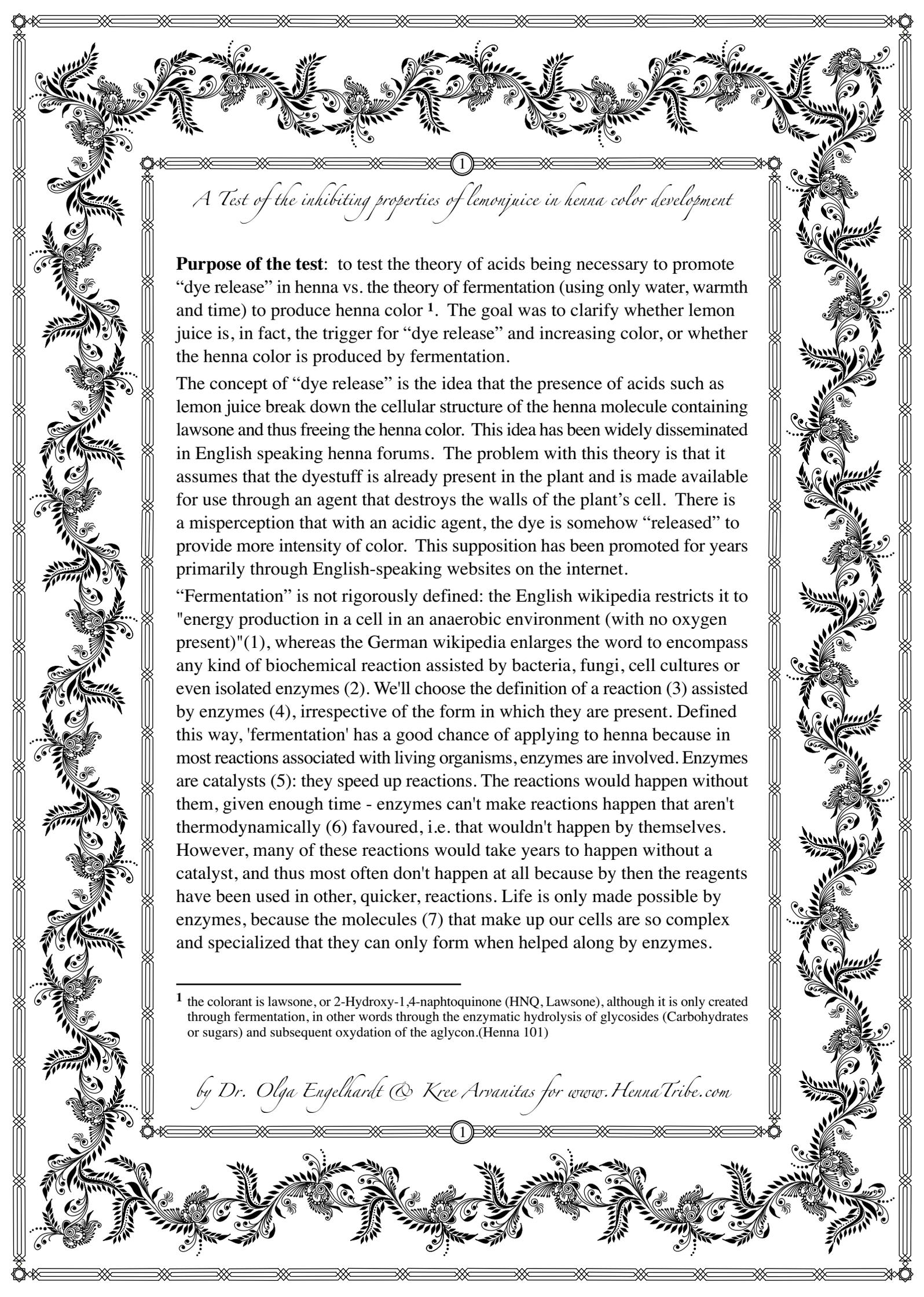
Purpose of the test: to test the theory of acids being necessary to promote “dye release” in henna vs. the theory of fermentation (using only water, warmth and time) to produce henna color ¹. The goal was to clarify whether lemon juice is, in fact, the trigger for “dye release” and increasing color, or whether the henna color is produced by fermentation.

The concept of “dye release” is the idea that the presence of acids such as lemon juice break down the cellular structure of the henna molecule containing lawsone and thus freeing the henna color. This idea has been widely disseminated in English speaking henna forums. The problem with this theory is that it assumes that the dyestuff is already present in the plant and is made available for use through an agent that destroys the walls of the plant’s cell. There is a misperception that with an acidic agent, the dye is somehow “released” to provide more intensity of color. This supposition has been promoted for years primarily through English-speaking websites on the internet.

“Fermentation” is not rigorously defined: the English wikipedia restricts it to "energy production in a cell in an anaerobic environment (with no oxygen present)"(1), whereas the German wikipedia enlarges the word to encompass any kind of biochemical reaction assisted by bacteria, fungi, cell cultures or even isolated enzymes (2). We'll choose the definition of a reaction (3) assisted by enzymes (4), irrespective of the form in which they are present. Defined this way, 'fermentation' has a good chance of applying to henna because in most reactions associated with living organisms, enzymes are involved. Enzymes are catalysts (5): they speed up reactions. The reactions would happen without them, given enough time - enzymes can't make reactions happen that aren't thermodynamically (6) favoured, i.e. that wouldn't happen by themselves. However, many of these reactions would take years to happen without a catalyst, and thus most often don't happen at all because by then the reagents have been used in other, quicker, reactions. Life is only made possible by enzymes, because the molecules (7) that make up our cells are so complex and specialized that they can only form when helped along by enzymes.

¹ the colorant is lawsone, or 2-Hydroxy-1,4-naphthoquinone (HNQ, Lawsone), although it is only created through fermentation, in other words through the enzymatic hydrolysis of glycosides (Carbohydrates or sugars) and subsequent oxydation of the aglycon.(Henna 101)

by Dr. Olga Engelhardt & Kree Arvanitas for www.HennaTribe.com

A decorative border with intricate floral and leaf patterns surrounds the text. At the bottom center of the border is a small circle containing the number 1.

A Test of the inhibiting properties of lemon juice in henna color development

Method of the testing:

We chose two varieties of henna; henna from Yemen, and henna from Rajasthan. We retained one water-only batch of each because a control batch of henna is necessary to track the results of the test.

Mixing and applying:

We took 4 cups and filled each with 4 teaspoons of henna. Two cups were filled with Yemeni henna and the other two filled with Rajastani henna. We labeled as follows:



Henna Powder

Y/W = Yemeni, water added
R/W = Rajastani, water added

Y/L = Yemeni, lemon only
R/L = Rajastani, lemon only

Additional Ingredient

12-14 teaspoons water only
(boiled and cooled)

12-14 teaspoons lemon juice
(squeezed from fresh lemons)

Test One – 15 minutes:

Henna was applied initially on two hands 15 minutes after henna was mixed.

by Dr. Olga Engelhardt & Kree Arvanitas for www.HennaTribe.com

A Test of the inhibiting properties of lemon juice in henna color development



On the right hand we applied both Rajastani hennas. On the left hand we applied both Yemeni hennas. The henna was left on the skin for 15 minutes, scraped off and photographed.

During this particular part of the test, neither of the Rajastani mixes produced color. Only the Yemeni mixed with water produced a bright color. – the Yemeni mixed with lemon juice showed only a pale orange. This was a clear indication that lemon juice hindered the development of color in the Yemeni variety of henna.



The results of the Rajastani were inconclusive at this point, because the Rajastani tends to take longer to develop any color under a variety of conditions.

by Dr. Olga Engelhardt © Kree Arvanitas for www.HennaTribe.com

A Test of the inhibiting properties of lemon juice in henna color development



It was noticed a few hours after adding the water and lemon juice that the shade of henna powders appeared somewhat lighter on the lemon juice side. The photo was taken approximately 11:00 pm with a flash.

Test Two - Overnight:

For the second part of the test, the goal was to leave the henna on for an extended period of time, testing the difference, if any, between the water mix and lemon juice mix, taking into account the longer development time of the Rajastani henna.

An application of each henna was applied to another hand – this time on fingertips. The henna (water & lemon varieties only) was wrapped and kept on overnight. The following morning, it was scraped off around 6:00 am.

The results of the test affirm that the Rajastani took longer to develop. It also indicates that both the Rajastani and Yemeni failed to develop a full color with the addition of lemon juice.

As is shown in the photo, the color of the Yemeni and the color of the Rajastani mixed with water do not show a significant difference, although their development times varied. Where the henna was mixed with lemon, the Yemeni shows a faint color, but the Rajastani shows nearly nothing.



by Dr. Olga Engelhardt © Kree Arvanitas for www.HennaTribe.com

A Test of the inhibiting properties of lemon juice in henna color development

This test is corroborated by the experience of other henna artists as discussed on the Hennatibe thread on use of lemon juice. (8)

Test Three – Addition of Essential Oils:

At this point we decided to expand the scope of our test by adding certain essential oils to determine if the oils impacted any or all of the water and lemon mixes. 10 drops of tea tree oil and 10 drops of clove oil were added to each cup of henna the night before, after the photo of the henna cups had been taken. The henna was then allowed to sit overnight in a covered area away from light. We now had a new configuration of henna to test.



Henna Powder

Y/W/EO = Yemeni, water, oil
R/W/EO = Rajastani, water, oil

Y/L/EO = Yemeni, lemon, oil
R/L/EO = Rajastani, lemon, oil

Additional Ingredient

12-14 teaspoons water
+ 20 drops essential oil

12-14 teaspoons lemon juice
+ 20 drops essential oil

by Dr. Olga Engelhardt © Kree Arvanitas for www.HennaTribe.com

A Test of the inhibiting properties of lemonjuice in henna color development



The henna was applied below the fingertips of the earlier test, the following morning around 8:00 a.m.

The henna was allowed to dry for two hours (until 10:00 a.m.) and then removed by scraping off with olive oil. The results are shown below:

Immediately after removal it can be seen that the hennas mixed with water and essential oil showed a significantly darker color than the hennas mixed with lemon juice and essential oil.



At first, there was no significant difference between the colors of henna mixed with oil and the henna mixed with water. By evening around 5:00 pm, however, the henna with essential oils became significantly darker, leading us to theorize that something like oxidation occurred after removal of the paste.

by Dr. Olga Engelhardt & Kree Arvanitas for www.HennaTribe.com

A Test of the inhibiting properties of lemon juice in henna color development

Summery of conclusions:

It was clear from this test that lemon juice hinders the development of henna color. It became also clear with this test that henna from different regions take more or less time to develop any color, but have similar end results.

Some questions raised for future testing were:

- Can the amount of time the paste remains on the skin be minimized by leaving the paste to ferment longer off the skin? (More convenient for customers)
- Do essential oils darken the henna color?
- What impact do henna variables such as variety, age, storage and mixing conditions have on the color results?

Our next test will focus primarily on the third question in order not to muddy the testing with too many variables.

Sources:

- (1) http://en.wikipedia.org/wiki/Fermentation_%28biochemistry%29
- (2) <http://de.wikipedia.org/wiki/Fermentation>
- (3) http://en.wikipedia.org/wiki/Chemical_reaction
- (4) <http://en.wikipedia.org/wiki/Enzymes>
- (5) <http://en.wikipedia.org/wiki/Catalyst>
- (6) <http://en.wikipedia.org/wiki/Thermodynamic>
- (7) <http://en.wikipedia.org/wiki/Molecules>
- (8) <http://www.hennatribe.com/viewtopic.php?t=2270&sid=32709ef12bbd023eab02f8d742c3e736>

by Dr. Olga Engelhardt © Kree Arvanitas for www.HennaTribe.com