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Ecofriendly Alternative Solutions for Rust Removal

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ABSTRACT

Rust formation in sea going ships is a common problem. So a study was conducted to establish the effectiveness of some ecofriendly and natural products as alternative solution for rust removal. The experiments conducted using citrus, lemon grass, vinegar and muriatic acid, showed that the combination of citrus with vinegar is most effective in rust removal. Although it is true that muriatic acid is a conventional and effective solution, yet it is a hazardous chemical. However, combination of citrus and vinegar is an ecofriendly and natural alternative for rust removal.

Key words: citrus, lemon grass, vinegar, muriatic acid, rust, rust removal

INTRODUCTION

In today's world of technology, ships are mostly made up of metals. Thus, rust is a common problem and sometimes the cause of ship's damage to hull and other parts of the ship if no intervention is applied. Rust or iron oxide is being formed due to the exposure of iron to air and water. This happens when iron melts in the water with the combination of oxygen. Eventually, the iron or metal will undergo corrosion. In order to remove the rust and prevent corrosion, crew onboard must apply a chemical that is highly acidic. Various chemicals are now used to remove rust. However, in using these chemicals, one must be careful in handling them because they can pose risks to human health (ASM International Corrosion: Understanding the Basics, 2000).

Muller (2004) pointed out that hydrogen corrosion of the aluminum can be inhibited by the chelating agent which is the citric acid. Moreover, agaric acid (α-hexadecyl-citric acid), was more effective in inhibiting corrosion compared to citric acid alone.

Knowing that the Philippines is a tropical country, this study will determine the alternative indigenous organic solutions against rust that is less harmful to human health And to the environment without compromising the financial standing of the consumers.

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MATERIALS AND METHODS

Materials

Materials used were citrus (*Citrofortunella microcarpa*), vinegar (acetic acid), extracted lemon grass (*Andropogon citratus* DC Stapf), muriatic acid, iron bars with rust (ferric oxide), distilled water, syringe, plastic container, timer, digital weighing scale and tong.

Methods

a. **Rusting the Iron Bars**

The iron bars having the same nature or properties were cut with the same length and width (3 x 2 inches). They were soaked in seawater for 21 days.

b. **Preparing the Juices**

Extraction of citrus fruit was done by cutting and squeezing it's juice in an empty container until it reached the desired quantity. In extracting the lemon grass, whole part of roots and leaves was used in grinding and adding

up of water with 3 kg: 3ml as a ratio. Organic vinegar was used.

c. **Preparing the Set-up**

The plastic container was divided into seven sets, one set for the control group which is muriatic acid and six sets for the experimental group composed of calamansi extract with distilled water, lemon grass extract with distilled water, organic vinegar with distilled water or combination of two juices. Each set of experimental group has three various concentrations with three replicates same with the control group.

d. **Measuring the Desired Volume on Each Set-up**

Each container contained a total volume of 50 ml extract. The quantity on each mixture depended on the percent value of a certain concentration. For 80% and 20% concentration, 80% of 50 ml is 40 ml and 20% of 50 ml is 10 ml. In 50% and 50% concentration, each had 25 ml and in 20% and 80% concentration, 10 ml and 40 ml, respectively.

e. **Measuring and Randomizing the Initial Weight of Metal Bars**

Metal bars were measured first as initial weight through a digital weighing scale. Fish-bowl method was used in randomization of metal bars. A total of 57 metal bars were labeled as: A-citrus with distilled water, B-lemon grass with distilled water, C-vinegar with distilled water, AB-citrus with lemon grass, AC-citrus with vinegar, BC-lemon grass with vinegar and D-muriatic acid (control).

f. **Distribution of Metal Bars and Randomization of Treatments**

Metal bars were distributed to containers which have the desired mixture of treatments such as A (citrus with distilled water), B (lemon grass with distilled water), C (vinegar with distilled water), AB (citrus with lemon grass), AC (calamansi with vinegar), BC (lemon grass with vinegar) and D (control) with concentrations: 80% and 20%, 50% and 50% and 20% and 80%. The treatments were again randomized through fish bowl technique following the complete randomized design (CRD). The immersion of metal bars lasted for 24 hours.

g. **Measuring the Final Weight of Metal Bars**

After 24 hours of immersing into mixture, the metal bars were again weighed and recorded. The difference between the initial weight and final weight determined the amount of rust removed in a given treatment.

h. **Data Analysis**

Descriptive and inferential statistics were used for the data analysis. The descriptive statistical tool used was the mean. It was used to determine the mean weight (ḡ) of rust exposed to different juices such as citrus, lemon grass and vinegar mixed with distilled water and the mixture of two juices after 24 hours of exposure in various concentrations: (a.) 80% -juice and 20% - distilled water; (b.) 50% -juice and 50% -distilled water; (c.) 20% - juice and 80% -distilled water; (d.) 80% - juice and 20% - other juice; (e.) 50% - juice and 50% - other juice; (f.) 20% - juice and 80% - other juice. One-way analysis of variance (ANOVA) and post-hoc (Scheffe test) were used.

RESULTS AND DISCUSSION

Figure 1 shows the final mean weight (ḡ) of rust after having been soaked 24 hours in various treatments and concentrations. In the mean weight (ḡ) of rust exposed to different concentration such as (a.) 80% and 20%; (b.) 50% and 50% and (c.) 20% and 80%, the mean weight (ḡ) in the concentration of 80% and 20% is the biggest among concentrations in treatment A (citrus with distilled water) – 0.803 ḡ, treatment B (lemon grass with distilled water) – 0.094 ḡ, treatment C (vinegar with distilled water) – 0.331 ḡ, treatment AB (citrus with lemon grass) – 0.756 ḡ and treatment AC (citrus with vinegar) – 1.418 ḡ. However, the mean weight (ḡ) in 20% and 80% concentration of treatment BC (lemon grass and vinegar) – 0.520 ḡ is biggest than other concentrations.

In the mean weight (ḡ) of rust exposed after 24 hours to different treatment such as (a.) treatment A (citrus with distilled water); (b.) treatment B (lemon grass with distilled water); (c.) treatment C (vinegar with distilled water); (d.) treatment AB (citrus with lemon grass); (e.) treatment AC (citrus with vinegar) and (f.) treatment BC (lemon grass with vinegar), the mean weight (ḡ) in 80% and 20% concentration of treatment AC (citrus with vinegar) – 1.418 ḡ is biggest among treatments followed by treatment A (citrus with distilled water) – 0.803 ḡ, treatment AB (citrus with lemon grass) – 0.756 ḡ, treatment C (vinegar with distilled water) – 0.331 ḡ, treatment BC (lemon grass with vinegar) – 0.095 ḡ and treatment B (lemon grass with distilled water) – 0.094 ḡ. The mean weight (ḡ) in 50% and 50% concentration of treatment AC (citrus with vinegar) – 1.281 ḡ is the biggest among treatments followed by treatment BC (lemon grass with vinegar) – 0.331 ḡ, treatment A (citrus with distilled water) – 0.284 ḡ, treatment AB (citrus with lemon grass) – 0.283 ḡ, treatment C (vinegar with distilled water) – 0.092 ḡ and treatment B (lemon grass with distilled water) – 0.010 ḡ. The mean weight (ḡ) in 20% and 80% concentration of treatment AC (citrus with

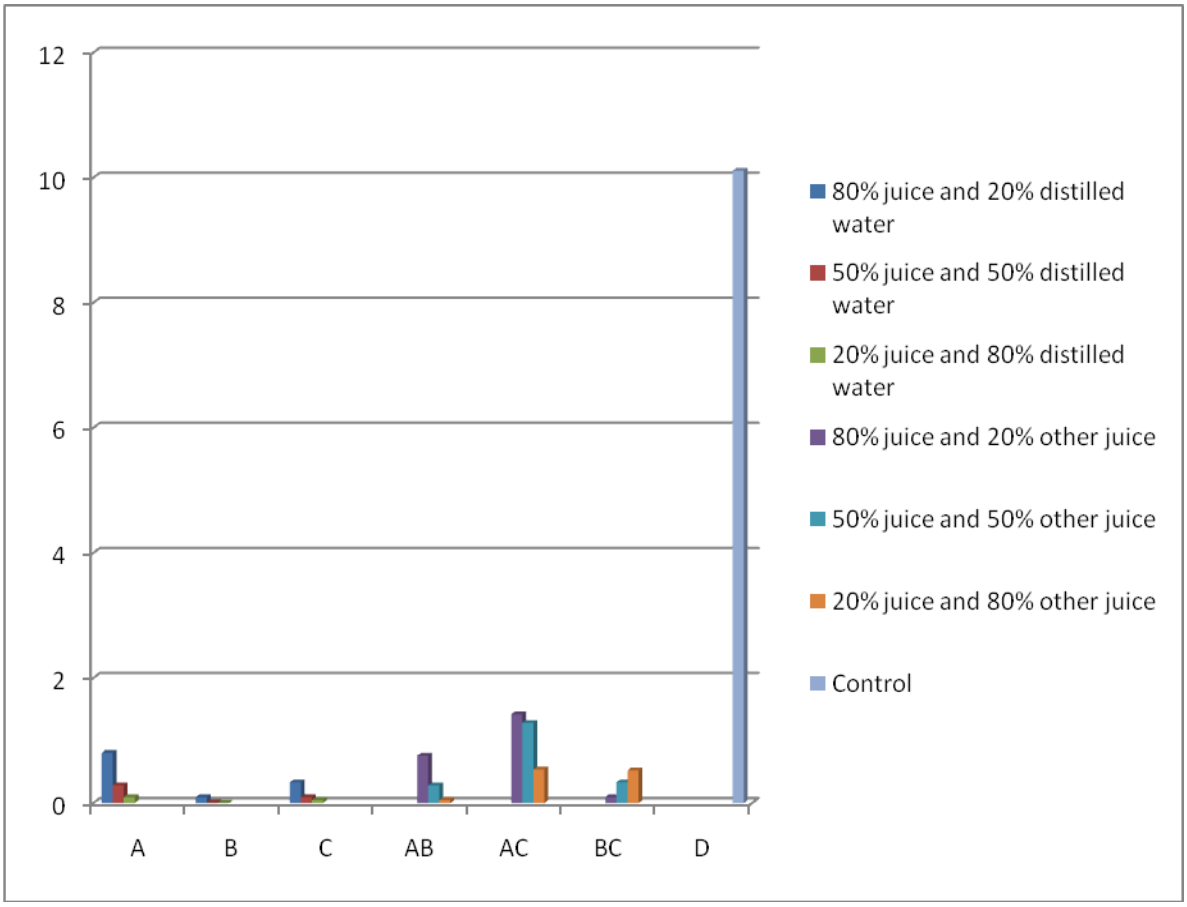

Figure 1: Mean weight in grams of removed rust among treatments after 24 hours.

A- Citrus with distilled water
B- Lemon Grass with distilled water
C- Vinegar with distilled water
D- Control
AB- Citrus with Lemon Grass
AC- Citrus with Vinegar
BC- Lemon Grass with Vinegar

vinegar) – 0.537 g̃ is the biggest among treatments followed by treatment BC (lemon grass with vinegar) – 0.520 g̃, treatment A (citrus with distilled water) – 0.094 g̃, treatment C (vinegar with distilled water) – 0.047 g̃ and treatment AB (citrus with lemon grass) – 0.047 g̃ and treatment B (lemon grass with distilled water) – 0.010 g̃.

The control-D (muriatic acid) treatment – 10.111 g̃ has the biggest mean weight of rust removed when compared to various treatments and concentrations.

Table 1, shows that after 24 hours, the mean weight of removed rust among treatments shows a significant difference between treatments, $F_{(6, 50)} = 112.061$, $p = .000$. On the other hand, Table 2 below shows that Treatments A, B, C, AB and BC shows no significant difference and Treatment A and Treatment AC also shows no significant difference.

In this case, Treatment D is the best treatment which is the control (muriatic acid).

The findings of the study shows that muriatic acid is still the best cleaning agent against rust because it has the highest mean weight (g) of rust removed and shows significant difference among other treatments. Muriatic acid contains hydrochloric acid however, it is hazardous to our environment and especially to human health. In the absence of muriatic acid, citrus with vinegar (80% and 20%) could be an alternative cleaning agent against rust.

This is for the fact that citrus contains citric acid while vinegar contains acetic acid. Citric acid has an advantage over some other acids, because it is renewable and non-toxic (Muller, 2004). Moreover, acetic acid present in organic vinegar in the present study can also remove rust.

Table 1
One-way ANOVA for Significant Difference in the Mean Weight (ḡ) of Rust Removed among Treatments after 24 Hours

Sources of Variation	Sum of Squares	df	Mean Square	F	Sig.
Treatment	16.959	6	2.827	112.061*	.000
Error	1.261	50	.025		
Total	18.220	56			

* - significant at .05 level of probability

Table 2
Scheffe test for Mean Weight (ḡ) of Rust Removed among Treatments after 24 Hours

Treatment	Mean weight (ḡ)
A	.404[ab]
B	.036[a]
C	.157[a]
AB	.362[a]
AC	1. 078[b]
BC	.315[a]
D	10. 111[c]

A- Citrus with distilled water
B- Lemon Grass with distilled water
C- Vinegar with distilled water
D- Control

AB - Citrus with Lemon Grass
AC - Citrus with Vinegar
BC – Lemon Grass with Vinegar

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