A Review on the Antioxidant Activity of Select Philippine Fruitsand Wines

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Abstract: Antioxidants are an abundant type of substance that is found in various fruits and wines. The literature on antioxidants has been growing consistently due to various reports on their health benefits. Hence, this study is a literature review of the antioxidant activity of local fruit and wines in the Philippines using various spectrophotometric techniques. Specifically, the researchers assessed the state of research on the antioxidant properties of local fruits and the effect of temperature and aging on the antioxidant activity of local wines. In gathering the related studies, the following keywords/phrases were used: "antioxidant activity of Philippine wines"," spectrophotometry", "Philippine fruit", and "temperature and age of Philippine wines." These were assessed using the Quality of Reporting of Meta-analyses (QUORUM) standard to measure its reliability. The results showed that there was a correlation between the temperature of both local fruits and wines towards the antioxidant ($x2c = 1.53$, $\alpha = 2.71$; $x2c = 5.00$, $\alpha = 6.25$, respectively). However, the age of the wine did not display any relationship with its antioxidant ($x2c = 11.56$, $\alpha = 6.25$). As for the heterogeneity of the studies, there was a considerable heterogeneity for the temperature of the fruits and wines towards the antioxidant ($I2 = 34.64\%$; $I2 = 40.00\%$). But the data for the age and wine were varied significantly since it accounted for a high heterogeneity ($I2 = 82.69\%$). In conclusion, there was a mildly significant correlation between the temperature of both fruit and wines towards the antioxidant activity. However, the wine age did not affect its antioxidant activity.

Key Words: Philippine fruits; antioxidant activity; Philippine wines; spectrophotometry; heterogeneity

1. INTRODUCTION

As of modern-day, the Philippines is not known for its wine production. However, its climate and culture contribute to its significant consumption and production of wine. The Philippine winery produces various types of wine which are commonly associated with the plants that grow locally. As a result, most of the wines that are being produced in the country are mostly local fruits such as strawberries, mangoes, pineapple, mangosteen, calamansi, and bignay (Morelock, 2018).

The antioxidants, which are sometimes called free-radical scavengers are considered to be a type of substance that has the ability to prevent or slow down the damage to the cells that are caused by free radicals (Morelock, 2018). Wines and fruits alike are found to have a significant amount of antioxidants which are commonly in the form of polyphenols, flavonoids, etc. (Barcelo, 2015). These compounds offer a lot to the human body because they aid in a lot of biological processes like anti-cancer or anti-inflammatory activities (Han et al., 2017).

The objective of this literature review is to provide sufficient information about the antioxidant activity of local fruit and wines that utilize various spectrophotometric techniques. The obtained literature will then be compared with each other in terms of the concluded results and the parameters observed in the experimentation process. For the fruit samples, the parameter that is considered is the temperature to which the sample was subjected during the experiment. Meanwhile, for the local wines, the parameters that are analyzed are the temperature during the experiments and the age of the local wines from the day of packaging. The review journal articles that were studied all took place in the Philippines and must use spectrophotometric techniques in acquiring data.

2. METHODOLOGY

The study is an intensive review of the Philippines' local papers about fruit and wines and their antioxidant levels. The researchers used various academic search engines in order to scour different articles. Among a few of the research engines used are Google Scholar, ScienceDirect, ResearchGate, Academia, and Philippine E-journal. To search for the relevant articles, the researchers used search strings such as "Antioxidant activity of Philippine wines", "spectrophotometry", "Philippine fruit", and "temperature and age of Philippine wines." The journal articles were assessed using the Quality of Reporting of Meta-analyses (QUORUM) standard. The researchers carefully filtered the articles utilizing a checklist to ensure the validity of the study's publications. The relevant data were presented in tabular form by indicating its age, temperature, and antioxidant activity. But for the fruits, only the temperature and antioxidant activity were indicated. Additionally, the chi-square test and Higgins' I2 heterogeneity statistic were used to assess the relationship of age and temperature on the antioxidant activity. This will be computed through a Microsoft Excel add-in called PHStat.

3. RESULTS AND DISCUSSION

Among the studies that have been searched, the researchers picked 31 pieces of literature based on the title and abstract of the paper. It consisted of both foreign and local literature therefore all the literature were consequently deducted by checking the criterion (see Table 1). Therefore, only 6 studies met the criterion which also needed to have a reliable result.

Table 1. The criteria used in the selection of studies

Parameter	Criteria
Date and Year	2005-2021
Author	Any author would suffice
Language	English
Research Status	Scholarly (Peer-reviewed)
General Setting	The antioxidant activity of Philippine fruit/ wines using spectrophotometric techniques
Methodology	Meta-analysis of journal articles using key terms to search the journal article repositories (ScienceDirect, Philippine E-journal, Google Scholar, and ResearchGate)
Publication	Any database that offers scholarly articles

Spectrophotometric techniques are methods that are reliant on the reaction of a radical, radical cation, or a complex antioxidant molecule that can donate a hydrogen ion. The 2,2-diphenyl-1-picrylhydrazyl DPPH method consists of a stable free radical which is caused by the delocalization of the spare electron within the totality of a molecule. The 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) method is a cation that is formed due to the loss of electrons from the nitrogen atom of ABTS which is a type of acid. The Ferric Reducing Antioxidant Potential (FRAP) method relies on the reduction of certain species through an antioxidant of the ferric ion. The Oxygen Radical Absorbance Capacity (ORAC) method measures the scavenging activities of the antioxidant against a peroxyl radical.

Table 2. Summary of the different spectrophotometric methods

Antioxidant capacity assay	Principle of the method	End-product determination
DPPH	Antioxidant reaction with an organic radical	Colorimetry
ABTS	Antioxidant reaction with an organic cation radical	Colorimetry
FRAP	Antioxidant reaction with a Fe(III) complex	Colorimetry
PFRAP	Potassium ferricyanide reduction by antioxidants and subsequent reaction of potassium ferrocyanide with Fe3+	Colorimetry
CUPRAC	Cu (II) reduction to Cu (I) by antioxidants	Colorimetry
ORAC	Antioxidant reaction with peroxyl radicals, induced by AAPH (2,2'-azobis-2-amidino-propane)	Loss of fluorescence of fluorescein
HORAC	Antioxidant capacity to quench OH radicals generated by a Co(II) based Fenton-like system	Loss of fluorescence of fluorescein
TRAP	Antioxidant capacity to scavenge luminol-derived radicals, generated from AAPH decomposition	Chemiluminescence quenching
Fluorimetry	Emission of light by a substance that has absorbed light or other electromagnetic radiation of a different wavelength	Recording of fluorescence excitation/ emission spectra

Note. Table 2 shows the process and result of the spectrophotometric methods (Pisoschi & Negulescu, 2012).

The Hydroxyl Radical Averting Capacity (HORAC) method relies on measuring the metal-chelating activities of antioxidants under Fenton-like conditions (ferric reactions). The Total peroxyl Radical-trapping Antioxidant Parameter (TRAP) method involves luminol enhanced chemiluminescence (CL) being exploited to measure the peroxyl radicals. The lipid peroxidation inhibition assay is a type of inhibition that uses a Fenton-like method to induce a lipid substance. The Potassium Ferricyanide Reducing Power (PFRAP) method involves the reducing capabilities of an antioxidant to reduce a ferric into a ferrous substance. The Cupric Reducing Antioxidant Power (CUPRAC) assay is a method wherein antioxidants are mixed with copper to be reduced. Lastly, Fluorimetry is utilized by exposing the antioxidant for it to emit a light that will emit energy (Pisoschi & Negulescu, 2003).

Garcia et al. (2005) acquired the bignay and durian from IFST and Davao City, respectively. The samples were kept and incubated at 37oC in a hot water bath. The experiment utilized the Lipid-peroxidation assay (Linoleic-acid) and resulted in an

84.44% antioxidant activity for the bignay and 90.76% for the durian. The study from Santiago et al. (2007) also used the Lipid-peroxidation assay to effectively identify the antioxidant of the local duhat and kalumpit. An 80.38% activity is found in duhat while kalumpit garnered 66.15% in their antioxidants. Additionally, Barcelo et al. (2015) employed the use of DPPH assay in their experiment involving pineapple, guyabano, strawberry, mangosteen, and ayosep fruit. All of these were kept under room temperature and yielded an antioxidant activity of 62.39%, 86.41%, 92.35%, 89.08%, and 80.02%, respectively. Lastly, a study by Lizardo et al. (2015) also aimed to study the antioxidant activity of bignay under 4oC. The DPPH assay was used and the result came out as the fruit having 87.10%.

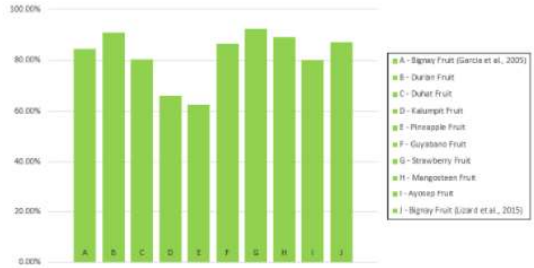

Figure 1. Comparison of the antioxidant activity of select Philippine fruits

Kalumpit Fruit	Lipid-peroxidation assay	40◦C	66.15%	Santiago et al. (2007)
Pineapple Fruit	DPPH radical scavenging assay	25◦C	62.39%	Barcelo et al. (2015)
Guyabano Fruit	DPPH radical scavenging assay	25◦C	86.41%	Barcelo et al. (2015)
Strawberry Fruit	DPPH radical scavenging assay	25◦C	92.35%	Barcelo et al. (2015)
Mangosteen Fruit	DPPH radical scavenging assay	25◦C	89.08%	Barcelo et al. (2015)
Ayosep Fruit	DPPH radical scavenging assay	25◦C	80.02%	Barcelo et al. (2015)
Bignay Fruit	DPPH radical scavenging assay	4◦C	87.10%	Lizardo et al. (2015)

The study by Hipol & Alma-in (2018) focused on tapuy, a rice wine that originated from the Cordillera regions, and assessed different variants of tapuy, each variant coming from different municipalities of Benguet. The researchers found out through the use of DPPH assay with ascorbic acid as the standard curve that the tapuy from Sablan had the most antioxidant activity to which was quantitated at 88.5%. Next, the tapuy from Trinidad ranked the lowest in antioxidant activity at 50.00%. Tapuy from the municipalities of Atok, Kapangan, Bokod, Tublay, and Tuba were calculated at 65.1%, 71.3%, 68.6%, 63.6%, and 76.6% respectively. 50 µL of each of the tapuy variants were analyzed at 37°C and were between 15-21 days old.

Dela Rosa & Medina (2021) is another research study that experimented on different types of rice wine with each wine differing in their originating rice varieties. The DPPH radical scavenging assay was used against the standard curve of gallic acid in order to determine the different wine samples' antioxidant activity. According to the researchers, the rice wine that was made from black rice (Ballatinao) had the highest antioxidant activity at 70.63% while the rice wine made from white rice (Bongkitan) had the lowest antioxidant activity at 45.44%. For the remaining rice wine varieties; red rice (Kintoman) and brown rice (Tinawon) had antioxidant activities of 57.66% and 57.20% respectively.

On the other hand, Barcelo et al. (2015) utilized the standard curve of gallic acid that was prepared in 80% methanol to quantify the results of the samples. The 6-month-old sample wines were left in a dark room at room temperature after being shaken thoroughly. The guyabano wine had the most % DPPH radical scavenging activity at 90.38% (±2.51), mangosteen wine had second-most at 89.55% (±0.76), then ayosep wine at 74.4% (±2.99), followed by strawberry wine at 69.95% (±12.8), and pineapple wine at 62.39% (±12.3).

Zubia & Dizon (2018) formulated their own fruit wines by blending three types of wines together with different proportions to compare the samples' antioxidant activity. The standard used was gallic acid to estimate the total phenolic contents of the different wine blends with the Folin-Ciocalteu method. 1000 µL of the sample wines were analyzed at room temperature after aging them for 3 months. The authors stated that the MPAPF blend's antioxidant activity is at 44.47%, then the 2M blend's is at 45.26%, the 2PA's blend at 42.67%, and lastly, the 2PF's blend is at 41.27%.

Table 4. Antioxidant activity of local wines evaluated using spectrophotometric techniques.

Type of Wine	Analytical Technique	Quantity of Wine Analysed	Temperature	Age	Antioxidant Activity	Author and Year
Tapuy wine (Sablan, Benguet)	DPPH radical scavenging assay	50 µL	37°C	15-21 days	88.5%	Hipol & Alma-in (2018)
Tapuy wine (Trinidad, Benguet)	DPPH radical scavenging assay	50 µL	37°C	15-21 days	50.0%	Hipol & Alma-in (2018)
Tapuy wine (Atok, Benguet)	DPPH radical scavenging assay	50 µL	37°C	15-21 days	65.1%	Hipol & Alma-in (2018)
Tapuy wine (Kapangan, Benguet)	DPPH radical scavenging assay	50 µL	37°C	15-21 days	71.3%	Hipol & Alma-in (2018)
Tapuy wine (Bokod, Benguet)	DPPH radical scavenging assay	50 µL	37°C	15-21 days	68.6%	Hipol & Alma-in (2018)
Tapuy wine (Tublay, Benguet)	DPPH radical scavenging assay	50 µL	37°C	15-21 days	63.6%	Hipol & Alma-in (2018)
Tapuy wine (Tuba, Benguet)	DPPH radical scavenging assay	50 µL	37°C	15-21 days	76.6%	Hipol & Alma-in (2018)
Tapuy wine (*Bongkitan*)	DPPH radical scavenging assay	100 µL	25°C	7 days	45.44%	Dela Rosa & Medina (2021)
Tapuy wine (*Tinawon*)	DPPH radical scavenging assay	100 µL	25°C	7 days	57.20%	Dela Rosa & Medina (2021)

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Type of Wine	Analytical Technique	Quantity of Wine Analysed	Temperature	Age	Antioxidant Activity	Author and Year
Tapuy wine (*Kintoman*)	DPPH radical scavenging assay	100 µL	25°C	7 days	57.66%	Dela Rosa & Medina (2021)
Tapuy wine (*Ballatinao*)	DPPH radical scavenging assay	100 µL	25°C	7 days	70.63%	Dela Rosa & Medina (2021)
Guyabano wine	DPPH radical scavenging assay	75 µl	25°C	6 months	90.38% (±2.51)	Barcelo et al. (2015)
Strawberry wine	DPPH radical scavenging assay	75 µl	25°C	6 months	69.95% (±12.8)	Barcelo et al. (2015)
Mangosteen wine	DPPH radical scavenging assay	75 µl	25°C	6 months	89.55% (±0.76)	Barcelo et al. (2015)
Ayosep wine	DPPH radical scavenging assay	75 µl	25°C	6 months	74.4% (±2.99)	Barcelo et al. (2015)
MPAPF*	DPPH radical scavenging assay	1000 µL	25°C	3 months	44.47%	Zubia & Dizon (2018)
2M**	DPPH radical scavenging assay	1000 µL	25°C	3 months	45.26%	Zubia & Dizon (2018)
2PA***	DPPH radical scavenging assay	1000 µL	25°C	3 months	42.67%	Zubia & Dizon (2018)
2PF ****	DPPH radical scavenging assay	1000 µL	25°C	3 months	41.27%	Zubia & Dizon (2018)

Note:
*MPAPF 33.33% mango wine + 33.33% pineapple wine + 33.33% passion fruit wine;
**2M - 50.00% mango wine + 25.00% pineapple wine + 25.00% passion fruit wine;
***2PA - 25.00% mango wine + 50.00% pineapple wine + 25.00% passion fruit wine;
****2PF - 25.00% mango wine + 25.00% pineapple wine + 50.00% passion fruit wine

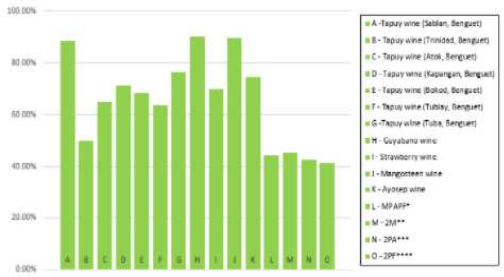

Figure 2. Comparison of antioxidant activity of various locally-available wines.

Statistical treatment was carried out in order to know the effects of temperature and age on the local wines and the effect of temperature on the fruits. The chi-square test was used to relate the age and temperature towards the antioxidant activity. As a result, the wine temperature and the antioxidant activity were found out to have a moderate correlation with each other ($x2c = 1.53$, $\alpha = 2.71$). Additionally, its age was found to have no significant correlation to the antioxidant activity of the wines ($x2c = 11.56$, $\alpha = 6.25$). But, the fruit temperature and its antioxidant activity were also found to have a significant correlation much like the wines ($x2c = 5.00$, $\alpha = 6.25$). Besides the relationship of the variables, Higgins' I2 heterogeneity statistics was utilized to find the variety of results in the given studies. The relationship between the wine temperature and antioxidant activity showed moderate heterogeneity ($I2 = 34.64\%$). Additionally, the age had a significant heterogeneity with the antioxidant ($I2 = 82.69\%$) while the fruit temperature was mildly homogenous with the antioxidant activity ($I2 = 40.00\%$).

4. CONCLUSIONS

With the results that the researchers have gathered, the fruit with the highest antioxidant activity was the strawberry fruit (Barcelo et al., 2015) and as for the wines, the wine with the highest antioxidant activity was the guyabano wine from the same study. Based on the available data, the researchers concluded that the antioxidant activity of both wines and fruits are affected by the temperature that they were subjected to while the age of wines do not. Additionally, the heterogeneity was also considerable in the data involving the antioxidant activity in relation to both temperatures in fruit and wine ($I2 = 34.64\%$; $I2 = 40.00\%$). But the heterogeneity of the antioxidant in regards to age is significantly high ($I2 = 82.69\%$) which concludes that the data are not that associated with each other. In conclusion, the temperature of the wine and fruit has a direct correlation to the antioxidant activity while the wine age does not have an important role.

Recommendations

Given the limited amount of data available about the antioxidant activity of Philippine fruits and wines, the researchers suggest that future studies should have more data to further confirm the findings in this paper. Specifically, a longer range of temperature from 0°C to 100°C and a longer age frame of wines from 7 days to 10 years would be more beneficial to better understand the relationship between the parameters of local fruits and wines.

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