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Qualitative analysis of phytochemicals in *Momordica charantia* Linn., *Moringa oleifera* Lam., *Tabernaemontana pandacaqui* Poir. and *Mollugo oppositifolia* Linn. crude ethanol leaf extracts as potential botanicals with wound healing property for castration of piglet

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Abstract

Botanicals possess healing and medicinal properties which could be an alternative to synthetic therapeutic drugs. The study was conceptualized to determine the phytochemical constituents, present in *Momordica charantia* Linn. *Moringa oleifera* Lam., *Tabernaemontana pandacaqui* Poir. and *Mollugo oppositifolia* Linn. crude ethanol leaf extracts and relate if the phytochemicals present have wound healing properties.. In Qualitative Phytochemical Evaluation, several methods were applied, i.e., crude ethanol leaf extraction procedure (cold maceration method) and Phytochemical Assay, to produce crude ethanol leaf extracts of the selected botanicals the subjected to various phytochemical tests to identify chemical constituents present using standard methods. Alkaloids, carbohydrates, essential oils, reducing sugars, fixed oils, tannins, polyphenols, flavonoids, proteins and saponins were qualitatively determined. The qualitative results were expressed as (++) for the presence of phytochemicals in significant amounts, (+) presence in trace amounts and (-) for the absence of phytochemicals. Crude ethanol leaf extracts of selected botanicals were subjected to phytochemical assay. Results showed that all plants contain reducing sugars, tannins, carbohydrates, polyphenols, and flavonoids which may have contributed to wound healing activity independently or synergistically.

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Introduction

Plant-derived substances have recently become of great interest owing to their versatile applications. Medicinal plants are the richest bio-resource of drugs of traditional systems of medicine, modern medicines, nutraceuticals, food supplements, folk medicines, pharmaceutical intermediates and chemical entities for synthetic drugs (Ncube *et al.*, 2008).

In the Philippines where herbal plants species abound, it is customary for Filipinos to use them in nursing minor sicknesses such as cough, colds, flu, infections, and other skin infections. Though there are still many Filipinos who still question the efficacy of these plants, medical researches and studies have already acknowledged their value in the world of medicine (Domingo, 2017).

In herbal medicine, crude plant extracts in the form of infusion, decoction, tincture or herbal extract are traditionally used by the population for the treatment of diseases, including infectious diseases. Although their efficacy and mechanisms of action have not been tested scientifically in most cases, these simple medicinal preparations often mediate beneficial responses due to their active chemical constituents (Wendakoon *et al.*, 2012).

The Aetas of Zambales have long used indigenous forest plants for food, clothing, construction, health and healing. It has been reported that the Aetas use several methods of plant preparation for medicine such as infusion (aqueous preparation of plant parts which are broken into small pieces in either cold or hot water); decoction (aqueous preparation of plants parts boiled with water for 15 minutes); sudorification (preparation of plant parts usually heated or smoked for the heat/smoke to be inhaled); and poultice (preparation of plant parts usually heated, spread in a cloth and applied to sore or injury). The Aetas believe that these plants with medicinal values are all naturally growing in the forest, and that the best time to gather them is on Good Friday. They also believe that with trees and medicinal plants being abundant, except in some cases, there is no need to plant them (America, 2004).

Natural products like herbal remedies have served human and animal populations in wound treatment for centuries due to their efficacy, accessibility, increasing scientific data on them and commercial interests (Barreto *et al.*, 2014). Most plants or parts thereof contain phytoconstituents that have wide ranging properties like antimicrobial, anti-inflammatory, antioxidant, antipruritic, hypotensive, proliferative, hypoglycemic, and analgesic that are often key in wound management or healing (Ayyanar and Ignacimuthu, 2009; Barreto *et al.*, 2014). Plants have been used as medicine since time immemorial for the treatment of various ailments of skin and dermatological disorders especially cuts, wounds and burns. They are in general far cheaper, and many can be gathered or home-grown virtually cost-free. Plants are rich in a wide variety of secondary metabolites such as tannins, terpenoids, alkaloids, flavonoids, glycosides, etc., which have been found in vitro to have antimicrobial properties (Dahanukar, 2000).

Many plants and various preparations have been used traditionally in relation to wound treatment, especially due to their immense potential to affect the wound healing process. Plant-derived extracts and/or isolates induce healing and tissue regeneration through multiple connected mechanisms, which often have a synergistic effect on the overall healing efficiency (Maver *et al.*, 2018). There are plants found in the Philippines that have different uses such as in the treatment of diseases and illnesses. Examples of these plants are *M. charantia* Linn (*Ampalaya*), *Moringa oleifera* Lam. (*Malunggay*), *T. pandacaqui* Poir (*Pandakaki-puti*) and *M. oppositifolia* Linn (*Papait*). These plants are being utilized by common folks in treating some illnesses. Thus, this study was conceptualized to determine the phytochemical constituents, present in *Momordica charantia* Linn. *Moringa oleifera* Lam., *Tabernaemontana pandacaqui* Poir. and *Mollugo oppositifolia* Linn. crude ethanol leaf extracts and relate if the phytochemicals present have wound healing properties.

Materials and methods

Plant material identification and collection

Fresh leaves of *M. charantia* Linn., *M. oleifera* Lam., *T. pandacaqui* Poir. and *M. oppositifolia* Linn. were collected in Bacnotan, La Union in the months of August and September, 2019. The plant species were identified and authenticated by the Forest Geneticist and Dendrologist of the College of Agroforestry and Forestry, Don Mariano Marcos Memorial State University, North La Union Campus, Bacnotan, La Union (Table 1).

Processing of plant materials

The leaves of the plants were thoroughly washed with tap water to remove dusts and other unwanted materials that have accumulated on the leaves from their natural environment. The dust free leaves were allowed to dry under the shade at room temperature for 3 days. The leaves of the four botanicals were ground using an electric blender. The ground leaves were stored in tightly closed glass containers at room temperature and later used in the extraction process.

Table 1. The identified plant materials

Local name	Common name	Scientific name	Family
Ampalaya	Bitter gourd	*Momordica charantia* Linn.	Cucurbitaceae
Malunggay	Drumstick tree	*Moringa oleifera* Lam.	Moringaceae
Kuribetbet	*Pandakaki-puti*	*Tabernaemontana pandacaqui* Poir.	Apocynaceae
Papait	Green carpet weed	*Mollugo oppositifolia* Linn	Aizoaceae

Crude ethanol leaf extraction procedure (cold maceration method)

The extracts of the plant materials were obtained using the conventional maceration method. About 250g of the coarsely powdered materials of each plant was placed in a stoppered glass container with 800ml of 70% ethanol (C_2H_5OH). The mixture was allowed to stand at room temperature for a period of 15 days (Epifano *et al.*, 2018). Long macerations promote the extraction processes because of the degradation of plant cell walls (Morata *et al.*, 2019). The swelling of plant cell wall increases the penetration of the solvent into the plant material, thereby increasing extract yield (Lee *et al.*, 2017). During this time, it was subjected to occasional stirring and shaking. The resultant suspensions were filtered into sterile beakers using muslin cloth. The filtrates collected were re-filtered into sterile sample bottles using Whatman No. 1 filter paper. The solvent from the extracts were subjected for evaporation using water bath (40 °C) until a sticky mass was obtained. The extract thus obtained was directly used in the phytochemical analysis, assay of antibacterial activity and treatment of castration wounds of piglets.

Phytochemical assay

The crude ethanol leaf extracts of the selected botanicals were subjected to various phytochemical tests to identify chemical constituents present using standard methods as described by Bhaskar and Nithya (2012). Alkaloids, carbohydrates, essential oils, reducing sugars, fixed oils, tannins, polyphenols, flavonoids, proteins and saponins were qualitatively determined. The qualitative results were expressed as (++) for the presence of phytochemicals in significant amounts, (+) presence in trace amounts and (-) for the absence of phytochemicals. The plant extracts were assessed for the existence of the phytochemical components by using the following standard methods:

Detection of alkaloids

The extracts were dissolved individually in dilute Hydrochloric acid and then filtered.

Mayer's test

The filtrates were treated with Mayer's reagent (Potassium Mercuric Iodide). Formation of a yellow colored precipitate indicated the presence of alkaloids.

Hager's test

A few drops of Hager's reagent were added to two milligrams of the crude ethanol leaf extracts in a test tube. Formation of yellow precipitate confirmed the presence of alkaloids.

Wagner's test

Ten milliliters of the extracts were acidified by adding 1.5% v/v of HCl and a few drops of Wagner's reagent. Formation of yellow or brown precipitate confirmed the presence of alkaloid.

Dragendorff's test

The filtrates were treated with Dragendorff's reagent (solution of Potassium Bismuth Iodide). Formation of red precipitate indicated the presence of alkaloids.

Detection of carbohydrates and reducing sugars

The extracts were dissolved individually in 5 ml distilled water and filter. The filtrates were used to test for the presence of carbohydrates and reducing sugars.

Molisch's test

The filtrates were treated with 2-3 drops of 1% alcoholic α-Naphthol and 2ml of concentrated Sulfuric acid was added along the sides of the test tube. Formation of the violet ring at the junction indicated the presence of Carbohydrates.

Benedict's test

The filtrates were treated with Benedict's reagent and heated gently. Orange red precipitate indicated the presence of reducing sugars.

Fehling's test

The filtrates were treated with diluted Hydrochloric acid, neutralized with alkali and heated with Fehling's A & B solutions. Formation of red precipitate indicated the presence of reducing sugars.

Detection of tannins and polyphenols

Gelatin test

A few drops of 10% gelatin solution were added to the crude ethanol leaf extracts. White precipitate indicated the presence of tannins.

Ferric chloride test

Extracts were treated with 3-4 drops of ferric chloride solution. Formation of bluish black color indicated the presence of polyphenols.

Detection of flavonoids

Alkaline reagent test

Two milliliters of the extracts were treated with few drops of 20% sodium hydroxide solution. Formation of intense yellow color, which becomes colorless on addition of dilute hydrochloric acid, indicated the presence of flavonoids.

Detection of essential oils

Spot test

A drop of water was placed on one end of a filter paper and a drop of the extract on the other end. The appearance of a translucent and greasy spot indicated the presence of essential oils.

Detection of saponins

Froth test

One milliliter of the extracts was diluted with distilled water to 6 ml and this was shaken in a graduated cylinder for 15 minutes. Formation of 1 cm layer of foam indicated the presence of saponins.

Detection of fixed oils

A few drops of 0.5 N alcoholic Potassium Hydroxide were added to small quantity of various extracts along with a drop of Phenolphthalein. The mixture was heated on water bath for 1.2 hours. Formation of soap or partial neutralization of alkali indicated the presence of fixed oils.

Detection of proteins

Lead acetate test

Two milliliters of 10% NaOH were added to 2 ml of the crude extracts and was allowed to boil for a minute. A drop of lead acetate solution was added. The formation of a brown or black precipitate confirmed the presence of proteins.

Data gathered and data analysis

Phytochemical components of the selected botanicals

These were identified through phytochemical screening of the selected botanicals (Table 2). All data were expressed as mean ± standard error of the mean (SEM). The statistical analysis was carried out by one-way analysis of variance (ANOVA) test at

different time intervals employing the statistical program, Statistical Tool for Agricultural Research (STAR). Significance of the difference between means was determined by Tukey's honestly significant difference (HSD) test and least significant difference (LSD) test. Differences between groups were considered statistically significant at P value < 0.05 levels.

Results and discussion

Phytochemical composition of the selected botanicals

The results obtained from the qualitative phytochemical screening of the crude ethanol leaf extracts of the selected botanicals are shown in Table 2. The study revealed the presence of reducing sugars, tannins, polyphenols, flavonoids and carbohydrates in the crude ethanol leaf extracts of *Momordica charantia* Linn., *Moringa oleifera* Lam., *Tabernaemontana pandacaqui* Poir. and *Mollugo oppositifolia* Linn.

Kodera *et al.* and Dhalel and Markandeya, as cited by Adeonipekun *et al.* (2014), mentioned that reducing sugars constitutes a building block in the production of phytoalexins which are antimicrobial substances synthesized by plants. Phytoalexins accumulate rapidly at areas of incompatible pathogen infection. The presence of reducing sugars in the crude ethanol leaf extracts could account for its antibacterial activity. This agrees with previous findings of various researchers on the antibacterial property of reducing sugars.

Tannins and flavonoids have been reported to possess a wide variety of biological activities among which are antimicrobial, anti-inflammatory, analgesic, anti-allergic effects, antioxidant, antiviral, antibacterial, antiparasitic, anticancer as well as antidiarrheal properties (Madike *et al.*, 2017). Tannins have been reported to hasten the process of wound healing as well as boosting antimicrobial activities of medicinal plants (Waweru *et al.*, 2017). The antibacterial activity of flavonoids may be due to their ability to form complexes with extracellular and soluble proteins and also with bacterial cell walls (Rajendrabhai, 2017). Polyphenols have been reported to have antiseptic, anti-inflammatory, antimicrobial, and antitumor properties (Okigbo *et al.*, 2009).

Alkaloids were found to be present in *Moringa oleifera* Lam. and *Tabernaemontana pandacaqui* Poir. However, they were absent in *M. oppositifolia* Linn. and *M. charantia* Linn. crude ethanol leaf extracts. Alkaloids have a wide range of pharmacological properties including antimalarial, antiasthma, anticancer properties as reported by Ajuru, *et al.* (2017). Additionally, alkaloids have been found to have anthelmintic, analgesic and antibacterial properties though they can be toxic too. Alkaloids tend to be poisonous when taken in bulk amount due to their stimulatory effects, producing excitation associated with cell and nerve disorders (Madhu *et al.*, 2016).

Carbohydrates were present in all the crude ethanol leaf extracts. Carbohydrates have not been found to have therapeutic effect, but may possibly increase the effectiveness of the therapeutically important ingredients (Auwal *et al.*, 2014). *M. oleifera* Lam. and *T. pandacaqui* Poir. crude ethanol leaf extracts contained fixed oils. Fixed oils are also known as carrier oils. They are the oily, non-volatile part of the plant. They are called "fixed" because they have large molecules that do not evaporate like the essential oils. It has been known to help relieve itching, soreness and dryness and other forms of inflammation (Keay, 2017).

Trace amounts of saponins were found in *M. oleifera* Lam. and *T. pandacaqui* Poir. crude ethanol leaf extracts. Saponins hasten numerous biological activities including hemolytic, anti-bacterial, anti-viral, and anti-oxidative functions. In addition, saponins reportedly have anti-inflammatory activity which can reduce edema and skin inflammation (Kim *et al.*, 2011).

Table 2. Qualitative Analysis of Phytochemicals in *M. charantia* Linn., *M. oleifera* Lam., *T. pandacaqui* Poir. and *M. oppositifolia* Linn. Crude Ethanol Leaf Extracts

Class of compound	*M. charantia* Linn.	*M. oleifera* Lam.	*T.pandacaqui* Poir.	*M. oppositifolia* Linn.
Alkaloids	(-)	(+)	(+)	(-)
Carbohydrates	(+)	(++)	(++)	(+)
Essential oils	(+)	(-)	(-)	(+)
Reducing Sugars	(++)	(+)	(+)	(++)
Fixed Oils	(-)	(+)	(+)	(-)
Tannins	(+)	(++)	(++)	(+)
Polyphenols	(+)	(++)	(++)	(+)
Flavonoids	(+)	(++)	(++)	(+)
Proteins	(-)	(+)	(+)	(-)
Saponins	(-)	(+)	(+)	(-)

Legend: (-) Absent; (+) Present in trace amount; (++) Present in significant amoun

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Proteins were present in small amounts in the crude ethanol leaf extracts of *M. oleifera* Lam. and *T. pandacaqui* Poir. Proteins are essential to the successful healing of a wound. In order for wounds to heal, protein synthesis must be present (Wounds Journal, 2019). Chronic and acute wounds, such as postsurgical wounds or pressure ulcers, require an increased amount of protein to ensure complete and timely healing of wounds. During the proliferative phase of wound repair, collagen deposition is crucial to increase the wound's tensile strength. Proteins are essential for rapidly proliferating cells during wound healing. They promote wound healing by increasing collagen deposition (Collins and Schnitze, 2013).

Crude ethanol leaf extracts of M. oppositifolia Linn. and *M. charantia* Linn. contained essential oils. Essential oils have antimicrobial, pesticidal, wound-healing promoting and antioxidant properties, owing to their pharmacologically active compounds, e.g. borneol, camphor, terpinen-4-ol, eucalyptol and many other compounds (Labib *et al.*, 2019).

Several studies have reported that variations in the quality of the phytochemicals could be a result of a number of factors: (a) the plant part used as starting material, (b) the solvent used for extraction, (c) the extraction technology, and (d) temperature and particle size of plant tissues. The solvent-to-sample ratio also affects the quantity and quality of constituents obtained. (Ncube *et al.*, 2008; Tiwari *et al.*, 2011). Furthermore, Madike *et al.* (2017) reported that a single solvent may not necessarily extract all the useful bioactive compounds from a plant. Several solvents may have to be used to obtain the best yields of specific compounds.

M. charantia Linn. (Bitter gourd), a slender, climbing and fruiting vine that belongs to the Cucurbitaceae family, is widely distributed in tropical and subtropical regions of the world and is cultivated as a food and medicine. It has been used in folk medicine for the treatment of diabetes mellitus, and its fruit has been used as a vegetable for thousands of years. Various biological activities of *M. charantia* Linn. have been reported, such as antihyperglycemic, antibacterial, antiviral, antitumor, antioxidant, antidiabetic, anthelmintic, antiulcer,

antifertility, anticancer and anti-inflammatory activities (Jia *et al*., 2017). Shih *et al.* (2009) asserted that bitter gourd is rich in various bioactive components containing minerals, alkaloids, vitamins, steroidal saponins, polypeptide, and aromatic volatile oil, apart from its usage as vegetable. Poolperm and Jiraungkoorskul (2017) also noted that this plant is rich in various saponins including momordicin, momordin, momordicoside, karavilagenin, karaviloside, and kuguacin, all of which have been reported to contribute to its remedial properties including antibacterial, antifungal, antiviral, and antiparasitic infections.

Sharma *et al.,* as cited by Ahamad *et al.* (2017), reported significant wound healing activity in animals treated with *M. charantia* Linn. extract compared to those who received the standard and control treatments. In excision wound model, *M. charantia* Linn. extract treated animals showed a significant reduction in wound area and period of epithelialization. The extract treated animals showed faster epithelialization of wound than the control. The wound healing activity of olive oil macerate of *M. charantia* was evaluated in linear incision and circular excision wound models created in the buccal mucosa of the rat. Olive oil macerate of *M. charantia* Linn. showed significant wound healing activity both in incision (45.1%) and excision (89.8%) wound models and demonstrated anti-inflammatory activity with the inhibition value of 31.3% at the dose of 100 mg/kg.

M. oleifera Lam. is a small, fast-growing, evergreen drought-resistant tree of the family Moringaceae, native to tropical Asia but also naturalized in Africa and tropical America. The leaves are nutritious and are high in iron, potassium, and vitamin C (Petruzzello, 2019). The different parts of the *Moringa oleifera* Lam. tree, including roots, bark, leaves, flowers, fruits, and seeds have been reported to possess many pharmacological activities which include analgesic, anti-inflammatory, antiasthmatic, anti-ulcer, antispasmodic, antibacterial, antihyperglycemia, antioxidant, anticancer and larvicidal activities (Okoye and Okereke, 2014). The extract of Moringa has been shown to help wounds close as well as reduce the appearance of scars (Cadman, 2017). Moringa is sometimes applied directly to the skin as a germ-killer or drying agent (astringent). It is also used topically for treating pockets of infection (abscesses), athlete's foot, dandruff, gum disease (gingivitis), snakebites, warts, and wounds (WebMD LLC, 2019).

Caceres *et al.* (2002) investigated *in vitro* the antimicrobial activities of *Moringa oleifera* Lam. leaves, roots, bark and seeds against bacteria, yeast, dermatophytes and helminths pathogenic to man. They reported that, by a disk-diffusion method, the fresh leaf juice and aqueous extracts from the seeds inhibited the growth of *Pseudomonas aeruginosa* and *Staphylococcus aureus* and that extraction temperatures above 56°C inhibited this activity.

Elangovan *et al.* (2014) reported in their study that chloroform and petroleum ether extracts of *Moringa oleifera* Lam. leaves revealed the presence of alkaloids, flavonoids, terpenoids, steroids, tannins, saponins and glycosides. Terpenoids and steroids present in *M. oleifera* Lam. leaves were described as being active against bacteria such as *Staphylococcus aureus* (Kasolo *et al*., 2010).

Moringa seeds contains pterygospermin, a potent antibiotic and fungicide effective against *Staphylococcus aureus* and *Pseudomonas aeruginosa* (Orwa *et al*., 2009). According to Gothai *et al.* (2016), ethyl acetate fraction of *Moringa oleifera* Lam. leaves might be a potential therapeutic agent for skin wound healing by promoting fibroblast proliferation and migration through increasing the wound closure rate corroborating its traditional use.

Tabernaemontana pandacaqui Poir. is a species of plant in the dogbane family, Apocynaceae, known as windmill bush and banana bush (Hyland *et al*., 2010). It is an evergreen shrub or small tree growing from 1 to 4 meters high. Leaves are elliptic-lanceolate

to oblong-elliptic, 5 to 12 centimeters long, narrowed at both ends, shining and short-stalked (Stuart, 2018). Its flowers feature white or pale yellow corolla lobes. The fruit is orange, red or yellow with paired follicles, each up to 7 cm (2.8 in) in diameter. The plant is found in a wide variety of habitats, particularly in drier areas (Middleton, 2004). The plant is sometimes gathered from the wild, mainly for local medicinal use (Fern, 2014).

Stuart (2018) reported that the leaves and stems of *Tabernaemontana pandacaqui* Poir. possess analgesic, antiprotozoal, anti-inflammatory, pesticidal, antibacterial, wound healing and anthelmintic activities. Additionally, chemical profiling of *T. pandacaqui* Poir. leaves revealed the presence of terpenoids, flavonoids, and anthraquinones while stems yielded alkaloids, and terpenoids. In Tiaong, leaves of the plant reportedly are used as "herbal viagra." to correct erectile dysfunction. Fifteen to twenty-five (15-25) leaves are boiled in 3 glasses of water for 10 minutes and then the decoction is drunk. Ifugao-migrants in the foothills of the Sierra Madre used the plant latex for wounds (Stuart, 2018).

Bernardo and Oliver (2000) studied on the antiseptic and healing properties of indigenous plants in the Philippines. They noted that the leaf juice of *T. pandacaqui* Poir. enhanced healing of wounds in rabbits by 4-6 days compared to povidone-iodine solution. The leaf juice of *T. pandacaqui* Poir. also prevented formation of pus. *Mollugo oppositifolia* Linn. is a slender, spreading or ascending, smooth, branched, annual herb, with branches as long as 10 to 40 centimeters. Leaves are opposite or whorled, spatulate, oblanceolate to oblong-obovate, 1 to 3 centimeters long, and up to 1 centimeter wide. Flowers are white and fascicled, with slender stalks up to 1 centimeter long. Sepals are 3 to 3.5 millimeters long. Capsule is ellipsoid, a little shorted than the sepals. Seeds are numerous and covered with raised tubular points (Stuart, 2016).

Mollugo oppositifolia Linn. belongs to the Family Aizoaceae, which includes dampalit, talinum, gulasiman, spinach, and alugbati - all wild food plants (Rotor, 2014). The plant is used as a stomachic, aperient and antiseptic. Maceration of pulverized material mixed with oil or water is used for wounds, joint pains, inflammation, diarrhea, fever, boils, furuncles and skin disorders (Stuart, 2016). Vishali *et al.* (2011) evaluated aqueous and ethanolic extracts of leaves, flowers and stems of *Mollugo oppositifolia* Linn. for secondary metabolites and antimicrobial activity. They reported that the antimicrobial activity of the plant was significant in the stem, leaf, and flower samples and the activity was attributed to saponins.

The presence of these phytochemicals implies that these plants may be used to promote wound healing. Their presence therefore seems to support the traditional use of the plants in the management of various diseases. Phytochemicals are non-nutritive substances present in plants, and some of them have the potential to provide better tissue remodeling when applied on wounds and to also act as proangiogenic agents during wound healing. Also, Phytochemicals are well known for their chemopreventive properties and are found to be beneficial in treating various disorders, including skin diseases. Phytochemicals protect the skin by quenching free radicals and reducing inflammation (Thangapazham *et al.*, 2016).

Conclusion

The significant findings of the study are the following: (a) all crude ethanol leaf extracts contained reducing sugars, tannins, carbohydrates, polyphenols and flavonoids and thus *Momordica charantia* Linn., *Moringa oleifera* Lam., *Tabernaemontana pandacaqui* Poir. and *Mollugo oppositifolia* Linn. crude ethanol leaf extracts exhibited pro-healing activity by affecting the various phases of healing process, wound closure, and epithelialization of castration wounds of piglets.

Based on the findings of the study, the presence of phytochemicals in the crude ethanol leaf extracts such as alkaloids, essential oils, fixed oils, proteins, saponins, reducing sugars, tannins, carbohydrates, polyphenols and flavonoids may have contributed to wound healing activity independently or

synergistically, thus have properties that accelerate the wound healing process. Since these crude ethanol leaf extracts have properties, thus which render them capable of promoting enhanced wound healing activity.

The use of *Tabernaemontana pandacaqui* Poir. and *Momordica charantia* Linn. leaves for the cost-effective treatment of castration wound of piglets is recommended. But there is a need to elucidate phytochemical components present in the extracts which might be responsible for wound healing, anti-inflammatory and antibacterial activities.

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