ASSESSING THE USE OF YERBA MATE WITH OTHER MEDICINAL PLANTS IN LEBANON

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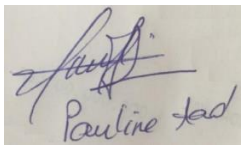

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ABSTRACT

Yerba Mate (*Ilex paraguariensis*) is a beverage that is highly consumed by certain communities in Lebanon. Several studies have shown the benefits of yerba mate consumption on one's health. Also, Lebanese add to their hot drink some medicinal plants that have been acquired by the society from the Arabian folk medicine. Many studies have been conducted, yet little is known about its effect on the Lebanese health, as they have been consuming it for almost 100 years. Therefore, this study was done to assess the use of yerba mate and medicinal plants. A questionnaire was distributed among 200 local Lebanese living in mountain's villages, suburbs and cities. Data was collected from yerba mate drinkers, yerba mate nondrinkers and medicinal plant drinkers. The reliability measures for this study were calculated using Cronbach's alpha. The results revealed that yerba mate is considered as a medicinal plant by less than half of the local Lebanese by its own medicinal virtues. This plant, however, is perceived by 36.5% of the participants as a very important vehicle for medicinal plants intake, where rosemary, chamomile, and aniseed are the mostly used. In addition, yerba mate drinkers use it, in the belief that it can treat diabetes, promotes a better heart health, eases digestion, relieves cold symptoms and ulcers irritations, lessen nausea, boosts immunity, mitigates menstruation and musculoskeletal problems, , aids in weight loss and cancer prevention, as well as lowering the cholesterol level.

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LIST OF ABBREVIATIONS

Yerba mate drinker (YD)

Yerba mate nondrinker (YND)

Yerba mate drinker with medicinal plant (YDM)

Medicinal plant drinker only (MD)

Living place (L)

Health of yerba mate drinkers (HYD)

Health of nondrinkers (HYND)

Dicaffeoylquinic (DCQ)

Reactive oxygen species (ROS)

Advanced glycation end product (AGE)

Low-density lipoprotein (LDL)

Ornithine decarboxylase (ODC)

Quinone reductase (QR)

Methylxanthines (MTXs)

Alzheimer's disease (AD)

β-amyloid peptide (Aβ)

Food and Drug Administration (FDA)

Ryanodine receptor type 3 (RyanR3)

Parkinson's disease (PD)

Cyclooxygenase-2 (COX-2)

Dicaffeoylquinic (diCQAs)

Human colon cancer cells CRL-2577 (RKO)

Chlorogenic acid (CGA)

Spray-dried powder (SDP)

Upper aerodigestive tract (UADT)

Esophageal squamous cell carcinoma (ESCC)

Polycyclic aromatic hydrocarbons (PAHs)

Kaempferol (KMF)

I. Introduction

1.1 General background about the topic

Ilex paraguariensis (yerba mate) beverage is a hot beverage that is usually prepared in a gourd, where grounded yerba mate infusion is ingested with a metal straw, *bombilla*, and a small volume of hot water is repeatedly added with every serving. This beverage has been popular worldwide particularly in South America and the Middle East (Reber, 1985). Yerba Mate is a native tree growing in the subtropics of South America. It is present in Southern Brazil, North eastern Argentina, Eastern Paraguay, and Uruguay. Migrants to these areas have also started to adopt some of the habits of the natives, including the ingestion of yerba mate. Europeans that moved or colonized Southern Brazil, Northeastern Argentina, and Eastern Paraguay in the 19th century started to drink yerba mate on daily basis (Reber, 1985). The same thing happened with Arabs, mainly Syrians and Lebanese, that migrated to Argentina in the second half of the 19th century (Folch, 2010). Those who returned back to their homeland countries in the 1920s brought back the habit of drinking yerba mate with them. Since that time, certain communities in Lebanon and Syria still drink yerba mate as a daily beverage especially in gatherings and as a substitute for a high caffeine intake from coffee and tea since yerba mate contains lower caffeine (Heckman, Weil, & de Mejia, 2010). Numerous studies showed that yerba mate has health benefits (Filip, Lotito, Ferraro, & Fraga, 2000). It is recommended by herbalists and popular medicine for arthritis, migraines, constipation, obesity, liquid retention, and hypertension (Bastos D. H., De Oliveira, Matsumoto, Carvalho, & Ribeiro, 2007). Current research is focusing on its efficiency in pharmacology to combat many diseases and as an effective antimicrobial agent against antibody-resistant strains. Yerba mate methanolic and ethanolic extracts have antimicrobial activity against food pathogens, such as *Staphylococcus aureus* , *Listeria monocytogenes*,

and *Salmonella* Enteritidis (Martin, Porto, de Alencar, da Glória, Corrêa, & Cabral, 2013). Many medicinal plants are added to yerba mate, whether in hot water thermos or in the gourd, in order to make it tastier. In addition it adds a great source of antioxidants, minerals, and vitamins.

Yerba mate consuming communities in Lebanon represent an ideal population where the use of yerba mate with and without the addition medicinal plants can be studied.

1.2 Problem identification

Several studies showed that yerba mate has various benefits regarding one's health, but little is known about its use in combination with other medicinal plants in Lebanon (Pontilho, Teixeira, Yuan, Luzia, Bastos, & Rondó, 2015). Yerba mate has a plenty of benefits on the individuals' health that are not well known by other communities in Lebanon and elsewhere. Studying the use of yerba mate and medicinal plants consumed by certain communities may help in providing new insights on mate consumption that could be extended to the larger community.

1.3 Research questions

Scientists and preventive medicine experts are seeking to find new prevention methods that individuals can adopt and add to their lifestyles to prevent or delay the occurrence of diseases. Based on several published studies it has been shown that several kinds of herbs when taken on daily basis in the form of tea or with food can decrease the chances of cancer,

boost immunity, provide antioxidants, and much more (Deeb T. , Knio, Shinwari, Kreydiyyeh, & Baydoun, 2013). Yerba Mate is one of these herbs that have beneficial effects on health when ingested alone with hot water (Kujawska M. , 2018). Yet it has been noticed that a great number of yerba mate drinkers add a variety of medicinal plants to their hot water thermos or gourd, especially in Lebanon's mountain villages and suburbs. Combining their knowledge in herbs and their development of Arabian folk medicine, these medicinal plants are added to yerba mate. However, there are no clear studies on the use of yerba mate with medicinal herbs on the individual's health. Exploring their use together may help researchers study their added health benefits.

Our study answers the following five questions regarding the potential effects of Yerba Mate and medicinal plants on one's health: What is the role of yerba mate in the treatment of illnesses? What are the differences in the health of yerba mate nondrinkers compared to drinkers? What is the effect of yerba mate combined with the medicinal plants? How do the medicinal plants affect the health of the yerba mate nondrinker? Are the health of mate drinkers and nondrinkers linked to the living place (the cities or the mountain and its suburbs) of the participants?

In this study, these research questions have been translated into the following five hypotheses, which were subsequently tested with data from the research that was conducted on local participants living in the mountain's villages/ suburbs and the cities. In order to abide by the Coronavirus pandemic precautions, questionnaire was made as a Google Form and sent to the participants which included the objective of the study.

- H 1: Yerba Mate has a significant role in the treatment of illnesses.
- H 2: Yerba Mate nondrinkers' health varies to that of drinkers'.

- H 3: Yerba Mate combined with medicinal plants positively influences the individuals' health.
- H 4: Medicinal plants positively influence the health of yerba mate nondrinker.
- H 5: The living place impacts the health of yerba mate drinkers and nondrinkers.

1.4 Objective and importance of the study

The objective of this study is to evaluate the use of yerba mate in Lebanon.

This study will ascertain the importance of frequently drank yerba mate on the participants' health compared to that of nondrinkers. It will also identify the effect of the addition of medicinal plants to the yerba mate beverage on health, which will be compared to the health of those who drink medicinal plants in the form of tea. In addition, it will help identify whether participants drink it for cultural/ traditional reasons or for its benefits and as a way to ingest medicinal plants. This study will also provide a guideline for potential benefits of mate, which can render it a new addition to the lifestyle to aid health. The study was conducted on Lebanese participants from the villages in the mountains and its suburbs, and from the cities. The results were analyzed using SPSS and compared to those in the western published studies.

II. Literature Review

2.1 Introduction

This chapter reviews the literature related to yerba mate and medicinal plants. The literature review is divided into six sections. The first section introduces yerba mate's (*I. paraguariensis*) origin, preparation process, and the history behind it reaching Lebanon. The second section reviews the chemical constituents of yerba mate, and the third section is related to health benefits of yerba mate and disease prevention. The fourth section tackles the role of medicinal plants in treating diseases, and the fifth and sixth sections discuss the use of yerba mate tablets and the synergistic effect of yerba mate and medicinal plants on health.

2.2 Yerba Mate: Ilex paraguariensis

2.2.1 Origin

Yerba mate (*Ilex paraguariensis*) is, a native tree found in the southern region of South America, to be specific, Brazil (Mato Grosso do Sul, Minas Gerais, Parana, Rio Grande do Sul, Rio de Janeiro, Santa Catarina, Sao Paulo), Argentina (Corrientes, Misiones), Paraguay (Alto Parana, Amambay, Caaguazu, Canendiyu, Central, Guaira, Itapua, Misiones, San Pedro), and Uruguay (Lavalleja, Maldonado, Tacuarembo, Treinta y Tres). *Ilex paraguariensis*, is a flowering subtropical dioeciously evergreen tree that belongs to the family Aquifoliaceae, 18 m in height, that gives yerba mate. It is considered as a holy plant. October to November is considered as the flowering period of the tree and March to June is for the fruit production. It's mandatory for the yerba mate plant to have an accurate manner of

annual rainfall both in amount, not less than 1200 mm, and distribution throughout the year. On the contrary, it's less sensitive to temperature. It can handle temperatures of - 6ºC to an average annual temperature of 21 to 22ºC. It is also able to endure frequent snowfalls in the mountainous region in which it resides.

152,000 hectares of yerba mate are planted in Argentina in the northeastern part of the country (Misiones and Corrientes) which is considered as the greatest producer, equivalent to 280,000 tons per year representing a large share from the overall local production rate. After Argentina, come Brazil and Paraguay as the second and third largest growers and producers of Yerba Mate respectively. It was reported that in 2002, 290,000 hectares were harvested worldwide. This area makes up to 874,678 tons of yerba mate. In 2004, it was rated that the production value of Yerba Mate was one billion dollars, globally (Heck & Mejia, 2007). The world production of yerba mate in 2016 amounted to 937,310 tons, mainly from Brazil, Argentina, and Paraguay (Pires, Pedrassani, Dallabrida, & Benedetti, 2016). The most common yerba mate type used among the locals in South America was the caagüazu, the variety planted on the Jesuit plantation. It has features of an orange tree and grows from four to eight meters in height. Although Argentina is the greatest Mate producer, Paraguayan Yerba Mate has been always outstanding compared to the Brazilian one. After 1900, it has also become a great product in the Argentinian market as soon as Paraguay started to harvest the local yerba mate.

In order to process yerba mate as an industry, four operations are required: gathering; preparation of leaves; conveyance to depot and packing; and transport to different markets.

Back in the seventeenth century, local populations had to cut and transform yerba mate on their own. In 1846, 44,000 arrobas (an Old Portuguese and Spanish unit of weight, mass, or volume) were produced from 71 small plantations or approximately 620 arrobas per

plantation. Therefore, the processing of yerba mate hasn't changed much since the 19th century. Entrepreneurs and the military took locations in order to build up buildings that would serve for the storage of supplies and yerba and to house workers. As the process begins with cutting, the leaves are cut once every two to three years and not annually as the Yerba Mate trees aren't deciduous so the leaves can last on the tree from one year to one another. Overcutting can kill the tree. A worker used to go up the trees and with a large knife cut off all branches with leaves until the tree was stripped and then set the branches into bunches, and stacked on a drying frame two meters above the ground. Beneath the drying frame a fire is illuminated that is gradually supplied with dry brush so it won't smoke, and kept on burning during the daylight hours. This stage usually needed 36 to 48 hours for the yerba mate to dry where the leaves lost half their weight. The dried yerba was stroked by wooden material or crushed by a stone grinder that relies on mules or horses to work. Laborers then organized the yerba into large hide bunches which had been made by cutting raw hide, doubling it lengthways, and stitching up the sides with hide strips or bands. Yerba mate was packed into these bags after they have been plasticized with water. After drying, the bags became stiff due to contracting in a solid bundle (Reber, 1985).

By the end of the 19th century, several Europeans have migrated to Southern Brazil, Northeastern Argentina, and, to a lesser extent, Eastern Paraguay. These countries were partially colonized by the European migrants that took the habit of drinking yerba mate as a daily beverage. It resumed till now where its consumption rate is estimated at more than one liter per day by millions of people in the previously listed countries for social reasons and as a source of caffeine. Drinking Mate isn't restricted only for its social role and a form for caffeine intake, but also for its pharmacological properties, as its marketability and popularity is increasing outside South America (Burris, Harte, Davidson, Stewart, & Zivanovic, 2012). These ethno-pharmacological characteristics of *Ilex paraguariensis* are obtained from dried

and minced leaves served as brewed tea, prepared in a very unique way. The evolution of *Ilex paraguariensis* as a tea drunk by the Guarani ethnic group has become a beverage with social properties and gained some rituals in some South American modern societies. When Mate industry has started by the Jesuits by encouraging its cultivation, it was later taken on by white people that named it “chimarrão” in Brazil, “maté” in Argentina and Uruguay, and “tereré” in Paraguay prepared with cold water in the summer (Bracesco, Sanchez, Contreras, Menini, & Gugliucci, 2011).

2.2.2 How did it reach Lebanon?

Mount Lebanon has witnessed during the second half of the nineteenth century, approximately by 1860, many local, regional, and international conflicts that led to civil wars. One of the consequences was the excessive migration of Syrians and Lebanese to the New World (Issawi, 1993). After 1861, migration has been boosted by peace, since the missionaries helped in the setup of medical dispensaries in addition to schools that diminished death- rate and uplift the educational level to meet the needs of a thriving tertiary sector. Demographic flourish has been witnessed in the Mount Lebanon area, driving an internal displacement of local Lebanese to nearby cities, particularly Beirut. Moreover, the overpopulated Mount Lebanon has led to internal emigration towards Beirut that in turn quadrupled between 1830 and 1850 and doubled between 1865 and 1920 (Fersan, 2010).

In the twentieth century, the Druze from Lebanon and Syria left to South America and attained the habit of drinking yerba mate. World Wars I and II intensified immigration to South America as well.

Yerba Mate has been linked to Lebanese and Syrians. These two countries, to date, are the largest importers and consumers outside South America. Yerba mate gives drinkers an identity distinguishing them from others in their society. This is noticed in Lebanon, similar to Argentine, Paraguayan, and Uruguayan identities within Spanish America, and gau´cho identity in Rio Grande do Sul, Brazil. Yerba mate points to the community identity and wealth, and shows familiarity among those who are drinking. As this habit has been practiced for quite a long time, carried from one generation to another referring to their financial success, business wit, and their international background that gave them experience and knowledge needed to acquire a successful wealth. This is shared during passing the Mate gourd around, while taking a moment of leisure and relief to chat. The international Mate beverage consumed by Druze has helped them maintain a distinct identity in a country that always had sectarian problems.

Syrians and Lebanese tend to share the *bombilla* (metallic straw with a filter at the bottom used to ingest Mate) while drinking, and this didn't seem as a problem to anyone. This could be linked to varied concepts of the body, of hygiene, and of the social agreement of passing tools from one mouth to another mouth (Folch, 2010).

2.2.3 Processing

Yerba mate processing requires several stages before packaging which includes blanching, drying, and generally aging of the tea. Although these stages are common, the conditions differ based on the producer and his/ her final purpose to reach the project in demand regarding style and flavor. Some of the conditions that differ while processing are the time and temperature of blanching and drying. Aging is also a variable as not all

producers apply it to their products, while others vary the aging time (Bastos, Fornari, Queiroz, & Torres, 2006). However, the total process is mostly the same. Figure 1A shows a process flow chart as a model for yerba mate tea. It starts with little fermentation and the blanching process that deactivates enzymes, that is, polyphenol oxidase. Blanching process varies between green tea, black tea, and yerba mate. Green tea leaves are steamed or pan-fried. Yerba mate tea leaves are flash heated over open flame. The leaves for black tea are allowed to wither and ferment and are not blanched before drying. Figure 1B shows the process for producing green and black teas. In black tea, the enzyme polyphenol oxidase is left to oxidize polyphenols to form dimerized compounds, that is, catechins to theaflavins (Hara, 2001). Yerba mate branches are cut, carried to the factory in open trucks, and placed in a freight yard before processing. Time varies between six to sixteen hours to cut the material and process it. The duration depends on distance between the plantation and the factory and climatic conditions (rainy or sunny). Climatic conditions fluctuate greatly during ripening where temperature can reach values between 0º C and 40º C. This variation can damage the material. Industrial processing of yerba mate operates as follows: blanching, drying, grinding, classification and seasoning. The blanching and drying stages involve changes in color, chlorophylls, and caffeine and moisture contents. Blanching is carried out in equipment similar to a rotating drier with co-current flow. Branches are placed for two to four minutes in contact with hot gases from burning propane or wood at temperatures ranging from 500º C to 550º C. Temperature of exit gases varies between 120º C and 200º C. Drying requires two stages. At every stage, cross flow driers are used topped with a bed of material up to 1 meter height. The entering air temperature is about 110º C and exit air temperatures range from 50º C to 60º C in the first stage and from 70º C to 80º C (-/+) in the second one. Dwelling duration is approximately 2 hours in each drying stage (Schmalko & Alzamora, 2001).

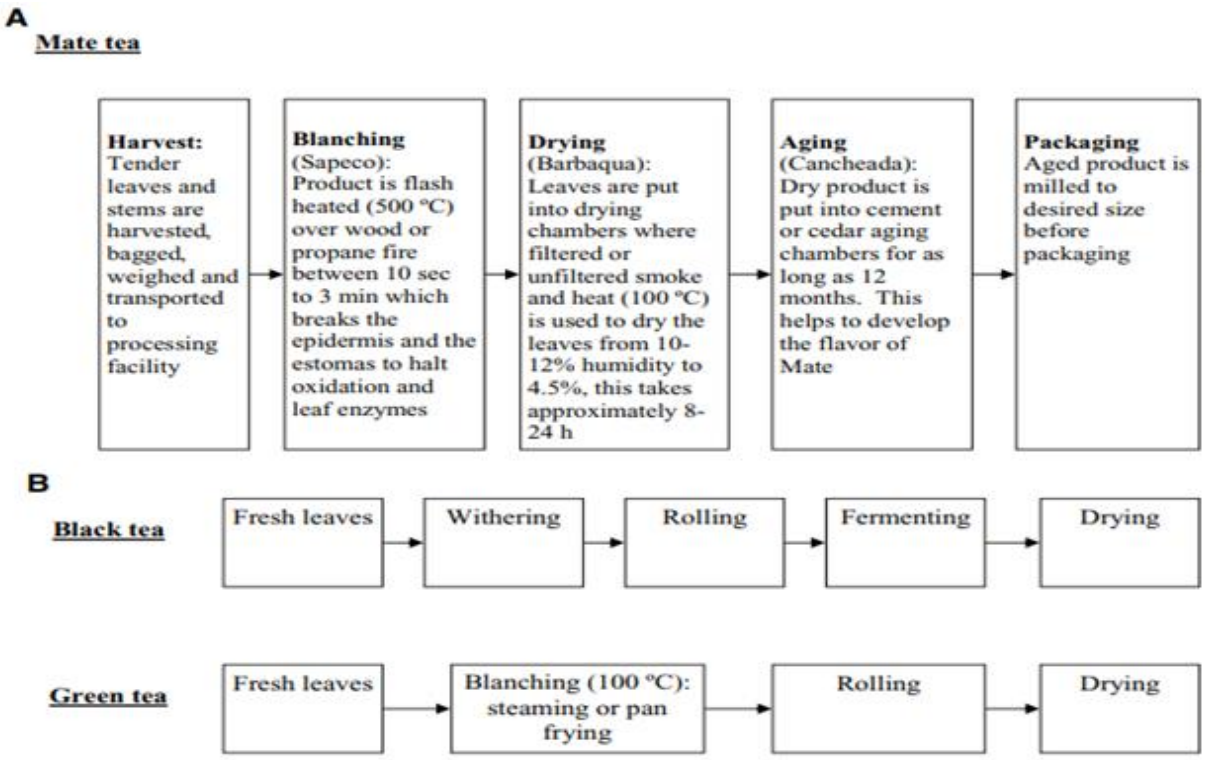

Figure 1: A. Flow chart for the processing of Ilex paraguariensis leaves into Yerba Mate tea (Adapted from Schmalko and Alzamora 2001). B. Flow chart for the processing of Camellia sinensis leaves into green and black teas (Adapted from Hara 2001).

2.3 Chemical Constituents

Phenolic compounds are the primary chemical constituents and the major bioactive factors of yerba mate that are made up of benzene rings attached to hydroxyl groups. The polyphenols in yerba mate mainly are: caffeic acid, caffeine, caffeoyl derivatives, caffeoylshikimic acid, chlorogenic acid, feruloylquinic acid, kaempferol, quercetin, quinic acid, rutin, and theobromine (Burris, Harte, Davidson, Stewart, & Zivanovic, 2012) (Table 1). *Ilex paraguariensis* industrial processing gradually affects the qualitative and quantitative composition and the pharmacological activities of yerba mate. The process starts with the green leaves, zapecado (a stage where 25% of the moisture is lost by the exposure to direct fire at temperatures between 250ºC and 550ºC during 2–4 min), and drying, forced or natural aging until reaching packaging. The samples that were studied revealed that after drying and

aging stages were rich in biologically active chemicals when compared with green leaves, whereas no differences were indicated between the natural and forced aging processes. The chemical compounds studied were, caffeoyl derivatives (caffeic acid, mono- and dicaffeoylquinic acids), methylxanthines (caffeine and theobromine) and flavonoids (rutin, quercetin and kaempferol) (Isolabella, Cogoi, López, Anesini, Ferraro, & Filip, 2010).

Table 1: The major bioactive compounds found in yerba mate and their health benefits; DCQ: Dicaffeoylquinic acid.

Chemical Compound	**Known health benefits**	**References**
Caffeoyl derivatives Chlorogenic acid	Antioxidant, antimicrobial, antidiabetic, analgesic	(Filip, López, Giberti, Coussio, & Ferraro, 2001)
	Antioxidant	(Heck & Mejia, 2007)
Caffeic acid	Anticancer, antioxidant	(Filip, López, Giberti, Coussio, & Ferraro, 2001); (Ribeiro, et al., 2019)
3,4- DCQ	Anticancer, antioxidant	
3,5- DCQ 4,5- DCQ	Anticancer, antioxidant	
Saponins	Anticancer, Anti-inflammation, antiparasitic	(Puangpraphant, Berhow, & de Mejia, 2011)
Xanthines		(Ouyang, Hou, Peng, Liu, & Deng, 2018)
Caffeine	Anticarcinogenic, antiobesity, antioxidant, diuretic, stimulant, vasodilator	(Heck & Mejia, 2007)
Theobromine	Stimulant, diuretic	(Heck & Mejia, 2007)
Theophylline	Stimulant, vasodilator	(Heck & Mejia, 2007)
Rutin	Antioxidant, lipoxygenase-inhibitor, anticancer, anti-tumor, anti-ulcer	(Heck & Mejia, 2007)
Quercetin	Anticancer, anti-inflammation, antimicrobial	(Vafadar, et al., 2020)
Kaempferol	Anti-inflammation, antimicrobial, antioxidant, anticancer	(Kashyap, Sharma, Tuli, Sak, Punia, & Mukherjee, 2017)
Syringic acid	Antioxidant, antimicrobial, anticancer, antidiabetic, anti-inflammatory, antiendotoxic, neuro and hepatoprotective activities	(Riachi, Simas, Coelho, Marcellini, da Silva, & de Maria, 2018); (Srinivasulu, Ramgopal, Ramanjaneyulu, Anuradha, & Kumar, 2018)

Ferulic acid	Anti-inflammatory, antioxidant	(Riachi, Simas, Coelho, Marcellini, da Silva, & de Maria, 2018); (McCarty & Assanga, 2018)

2.4 Yerba Mate Health Benefits and Disease Prevention

Antioxidants

Several *Ilex* species have been found worldwide that is of benefit to the individual's health, yet *I. paraguariensis* has been shown to have the highest antioxidant capacities and that was found to be positively correlated with the concentration of caffeoyl derivatives (Filip & Ferraro, 2003). Hence, frequently drank mate affects the overall antioxidant and caffeoylquinic acid derivatives intake (Bracesco, et al., 2003).

Heart health

The high polyphenol concentration in yerba mate has been shown to be linked to the peroxidase- like activity to suppress reactive oxygen species (ROS). Yerba mate has an inhibitory effect on the oxidative stress caused by ROS which mainly affects the liver and the heart. Oxidative stress affects the heart health during the postischemic reperfusion, returning blood flow to the organ and tissue after heart attack, caused by the generation of ROS. Hence, yerba mate constituents have showed to form a protection to the myocardial tissue by decreasing the lipid oxidation in the heart (Schinella, Fantinelli, & Mosca, 2005).

In addition, yerba mate can inhibit dicarbonyl action based on specific doses. Dicarbonyl plays a major role in hyperglycemia causing diabetic complications since they are related to advanced glycation end product (AGE) formation (Lunceford & Gugliucci, 2005).

Low-density lipoprotein (LDL)

Moreover, yerba mate displayed an effect on lessening low-density lipoprotein (LDL) by inhibiting lipid peroxidation as well as DNA oxidation. Free radical induced oxidation of LDL influences atherosclerosis (Bracesco, et al., 2003).

Obesity is a major concern for researchers worldwide that are trying to find changes in the lifestyle that aid in weight loss. Yerba mate is one of the beverages that when frequently ingested helps in losing weight and can be considered as a dietary supplement, where it showed to decrease respiratory quotient that indicates an increase in fat oxidation (Martinet, Hostettmann, & Schutz, 1999). This herbal infusion can slow the gastric emptying, decrease body fat mass and body fat percentage, lower waist-hip ratio, and reduce the duration for gastric fullness that will consequently increase satiety (Kim, Oh, Kim, Chae, & Chae, 2015).

Cancer

Regarding cancer, yerba mate has revealed an anticancer activity where in *in vitro* chemo-preventive studies related to cytotoxicity, that is in turn associated to anticancer activity, showed that yerba mate has high cytotoxicity against human cancer cells, particularly the liver. Ornithine decarboxylase (ODC), quinone reductase (QR) activities via HepG2 cells, and topoisomerase inhibitory activity were studied for cytotoxicity. ODC is found in high quantities in tumor cells and enhances tumor growth. QR helps in detecting any anticancer activity, in addition to topoisomerase that doubles in concentration in cancerous cells in order to increase the high cell division compared to the normal healthy cells. It has been found that IC_{50} of value 12µg eq (+) catechin/ml of yerba mate tea or beverage is needed to induce an inhibitory effect against growth of HepG2 cancer cells, whereas IC_{50} for green tea is 72µg eq (+) catechin/ml is required to achieve the same purpose (Ramirez-Mares, Chandra, & de Mejia, 2004).

Methylxanthines (MTXs), a bioactive principle of yerba mate, have health benefits for patients diagnosed with diseases involved with cell death in the nervous system. However, some studies have indicated that, regardless of the temperature; yerba mate can increase the odds of occurrence of upper aerodigestive tract (UADT) cancer. UADT cancers were found to be frequent among Latin American populations that regularly consume yerba mate. A meta-analysis was conducted to check is there is an association between yerba mate consumption and occurrence of the UADT cancer. 569 studies were included related to associations between yerba mate consumption and occurrence of UADT cancer. Out of the 569 studies, 18 met the inclusion criteria for qualitative and 15 for quantitative analysis. Increased odds were observed regarding yerba mate consumption and overall occurrence of UADT cancer. Consistent evidence of a positive association was found for all UADT sub-sites, oral, pharynx, esophagus and larynx. No differences in effect were found between consumption of cold/warm and hot/very hot mate. Hence, consumption of more than one liter of yerba mate per day was associated with increased odds of having UADT cancer compared to an intake of less than one liter per day (Mello, Scotti, Melo, Warnakulasuriya, Guerra, & Rivero, 2018).

In addition, another study tackled the association of yerba mate with increased risk of esophageal squamous cell carcinoma (ESCC). Yerba mate contains high levels of carcinogenic polycyclic aromatic hydrocarbons (PAHs), which are acquired during the traditional drying process. 244 adults participated in the study that answered a questionnaire and collected a fasting spot urine specimen. Urinary concentrations of seven PAH metabolites were quantified and assessed. The results revealed that yerba mate consumption showed a significant dose–response association with 6 of 7 PAH metabolites in unadjusted models. After adjustment for creatinine and potential confounders, concentrations of 2-naphthol, 1-hydroxyphenanthrene, and the sum of 2-

and 3-hydroxyphenanthrene remained significantly associated with recent yerba mate intake. The sum of the urinary concentrations of the phenanthrene metabolites was similar or higher among yerba mate drinkers who did not smoke than among smokers who did not drink yerba mate. Thus, urinary concentrations of PAH metabolites were significantly associated with self-reported amounts of recent yerba mate intake, and drinking yerba mate increased urinary concentrations of some PAH metabolites as much as smoking cigarettes. Therefore, drinking yerba mate is a source of exposure to potentially carcinogenic PAHs (Lopes, et al., 2018).

On the other hand, kaempferol (KMF), a polyphenol in yerba mate, has therapeutic applications such as anti-cancer, antioxidant and anti-inflammatory uses. KMF acts on a range of intracellular and extracellular targets involved in the cell signaling pathways that regulate the hallmarks of cancer growth progressions like apoptosis, cell cycle, invasion or metastasis, angiogenesis and inflammation (Kashyap, Sharma, Tuli, Sak, Punia, & Mukherjee, 2017). Recent in vitro and in vivo studies have shown the antiproliferative and proapoptotic activities of KMF against various types of cancers including breast (Liao, Chen, Ma, Jiao, Li, & Wang, 2016), ovarian (Luo, Rankin, Li, DePriest, & Chen, 2011), lung (Kuo, et al., 2015), pancreas (Kwon, Nam, Kim, Kim, Yoon, & Kim, 2009), esophagus (Yao, Wang, Li, Zhao, Jin, & Fang, 2016), stomach (Song, et al., 2015), colon (Cho & Park, 2013), bladder (Dang, et al., 2015), and kidney (Song, et al., 2014).

In addition, quercetin has shown great anti-cancer and anti-inflammatory properties. In vitro and in vivo experiments have revealed that quercetin has a cytotoxic effect on ovarian cancer cells. Quercetin can prevent ovarian cancer through anti-infammation, pro-oxidation, anti-proliferation, and cell cycle arrest. It can strengthen the impacts of other chemotherapeutic medications. Besides various advantages, utilization of quercetin

is associated with different limitations such as very poor bioavailability, poor absorption, rapid metabolism, chemical instability, and rapid systemic elimination. Utilization of quercetin analogs and targeting quercetin by nanotechnology-based approaches may therefore overcome these limitations. Hence, it seems that these platforms can potentially open new horizons in the utilization of quercetin as powerful therapeutic agent alone or in combination with other drugs in the treatment of different types of cancer such as ovarian cancer (Vafadar, et al., 2020).

Alzheimer's disease

Alzheimer's disease (AD) is a neurodegenerative disease that causes gradual loss of memory, language and learning capabilities, with symptoms differing among patients. The neuronal death is due to protein aggregates obtained from hyper-phosphorylated tau protein or unusual processing of the amyloid precursor protein. AD is characterized by damages in the synapses between neurons in the frontal/ entorhinal cortices when β-amyloid peptide (Aβ) deposits in senile plaques (a classical feature of AD) before the start of cognitive deficits. Several U.S. Food and Drug Administration (FDA) approved anti-AD drugs have been in the market yet after several years, they have showed very minimal progress in terms of cognitive or neuro-protective properties. Hence, this was the trigger to include MTXs in drugs and in the lifestyle as it has been found that MTXs lower the expression of phospho-JNK and phospho-ERK. These aggregations are pro-apoptotic. They provoked pro-survival signaling factors: PKA and phospho-CREB. In addition, MTXs' actions have showed effects on mediating the activation of ryanodine receptor type 3 (RyanR3) latter in the disease or downregulating the synaptic changes by p38MAPK-mediated events. However, further research should be done to investigate the neuroprotective pathways targeted by MTXs. Regarding AD in humans, several factors can interfere in the neuroprotective pathways that can change the effects of MTXs.

Some of these factors can be genetic, epigenetic, race, gender, habits, etc. However, there is an underestimation for the humans' consumption of caffeine (a central nervous system stimulant of the methylxanthine class) as MTX is naturally or artificially present in a large amount of foods/beverages, e.g., chocolate, colas or energy drinks, breath fresheners, weight loss pills, etc. Therefore, caffeine intake through certain commonly ingested foods and beverages can potentiate the neuro-protective effects of MTXs (Chang & Ho, 2014).

Parkinson's disease (PD)

Parkinson's disease (PD) is another very common neurodegenerative disease. Patients diagnosed with PD suffer from tremor, rigidity, bradykinesia and postural instability. These symptoms render the patients to go through psychiatric alterations and/or dementia sometimes. PD is defined as the gradual deficiency of dopaminergic neurons in the *substantia nigra pars compacta* (located in the midbrain) that results in an undersupply of striatal dopamine which in turn influences the motor control and compromises overall dopaminergic neurotransmission (Zigmond & Burke, 2002). Therefore, any treatment or medication has focused on promoting compensatory mechanisms to get back the motor and functional imbalance. However, all of these efforts were not enough to discontinue the neurodegeneration (Obeso, Rodriguez-Oroz, Lanciego, & Rodriguez, 2004). It has been reported that individuals who frequently have coffee have a lower probability of suffering from PD as they get older (Ascherio, et al., 2001). The previous outcome has been also seen in the prospective longitudinal studies that were conducted onto cultures and societies around the world, i.e., Japanese, American (Ross, et al., 2000), or Chinese (Tan, et al., 2008). A meta-analysis study published in 2014 displayed that caffeine has a dose-dependent neuroprotective role in

PD, where it has been advised for the individuals to take up to three cups of caffeinated coffee per day to reach the maximum protection (Qi & Li, 2014).

Anti-inflammatory effect

I. paraguariensis has been reported to have an anti-inflammatory effect by inhibiting the NF-κB signaling pathway through suppressing the phosphorylation of upstream IκB-α and GSK-3β (Pimente, et al., 2013). This promotes the blockage of downstream iNOS and cyclooxygenase-2 (COX-2) expression, and the secretion of inflammatory cytokines (Puangpraphant, Dia, de Mejia, Garcia, Berhow, & Wallig, 2013). Yerba Mate's anti-inflammatory effect has been witnessed in animals in various models, such as pleurisy in mice in the doubled membrane thin layer that separates the lungs from the chest wall (Luz, da Silva, Nascimento, de Campos Facchin, Baratto, & Frode, 2016), acute lung inflammation caused by cigarette smoking in mice (Lanzetti, et al., 2008), inflammation in obese rats (Pimente, et al., 2013), inflammation in rat colon provoked by azoxymethane (Puangpraphant, Dia, de Mejia, Garcia, Berhow, & Wallig, 2013), and acute edema in a mouse model (Schinella, et al., 2014) at concentrations ranging from 150 mg/kg to 250 mg/kg. In humans, dicaffeoylquinic (diCQAs) in yerba mate act as anti-cancer agents and can lessen other diseases also associated with inflammation. It has been shown that diCQAs inhibit Human colon cancer cells CRL-2577 (RKO) and HT-29 cell proliferation by provoking apoptosis in a time- and concentration-dependent manner, but did not affect the protein levels of p21, p27, p53, and Bax:Bcl-2 ratio in RKO cells. On the other hand, in HT-29 cells, the diCQA fractions increased Bax:Bcl-2 ratio. The diCQA fractions increased the activation of caspase-8 leading to cleavage of caspase-3 in both RKO and HT-29 colon cancer cells (Puangpraphant, Berhow, Vermillion, Potts, & de Mejia, 2011).

Digestion

Regarding digestion, a study was conducted to check the influence of *in vitro* gastrointestinal digestion and colonic fermentation on the stability of the polyphenols and on the antioxidant, antimicrobial and antitumor activities of the yerba mate beverages. The phenolic chromatographic profile showed that both the *in vitro* digestion and the colonic fermentation caused an evident reduction in 3,5-Odicaffeoylquinic acid and 5-O-caffeoylquinic acid in the preparations. However, 3-O-caffeoylquinic acid, 4-O-caffeoylquinic acid and salvianolic acid I, showed a very minimal variation in all preparations. Despite the decrease in the phytochemicals content, yerba mate beverages maintain their functional properties such as antioxidant, antibacterial and antitumor activities (Correa, et al., 2017).

Arthritis, fatigue, and headaches

Herbalists recommend the use of yerba mate for arthritis, fatigue, and headaches (Bastos & Torres, 2003). Yerba mate is considered as a CNS stimulant and anti-fatigue. It has been found that Yerba mate promotes the carbohydrates breakdown during exercise for a long duration through metabolism, which will enhance calories' burning, thereby increases cardiac activity and delays the build-up of lactic acid (Bastos, De Oliveira, Matsumoto, Carvalho, & Ribeiro, 2007). Additionally, yerba mate is rich with chlorogenic acid (CGA) that has several health benefits to the individual's health, where it has been noted that yerba mate can help in decreasing cold symptoms. CGA becomes shikimate via quinate, 3-dehydroquinate and 3-dehydroshikimate (Adachi, Ano, Toyama, & Matsushita, 2006). Shikimate is important as the direct precursor for Oseltamivir synthesis, the potent and selective competitive inhibitor of influenza A and B neuraminidase (Enserink, 2006) preventing people from pandemic flu infection, as well as for the synthesis of antibiotics, amino acids and agrochemicals. However, yerba

mate, that contains caffeine, is considered as a stimulant and sometimes added to energy drinks. Caffeine which is the most alkaloid ingested worldwide, can lead to gastrointestinal complications such as heart burn, increased esophageal reflux and gastric secretion with susceptibility to ulceration, both in acute and chronic intoxication (Ayoub & ElBeshbeishy, 2016). In a research that was held in Misiones, Argentina, in 2014 and 2015 on 100 Paraguayan migrants, menstruation and musculoskeletal problems decreased based on the respondents answers due to yerba mate ingestion and the addition of medicinal plants to the beverage (Kujawska M. , 2018).

2.5 Medicinal Plants in the treatment of diseases

Lebanon is endowed with a great variety of medicinal plants that have played a great role in the development of Arabian folk medicine and its trade. These plants have been cultivated or imported to Lebanon. Table 2 presents some of the medicinal plants that are frequently ingested by Lebanese in the form of tea or by adding them to the hot mate beverage (Deeb, Knio, Shinwari, Kreydiyyeh, & Baydoun, 2013).

Table 2: Summative list of medicinal plants used with mate beverages by participants

Family	**Scientific name**	**Local name**	**Plant part used**	**Medicinal application**	**Mode of preparation**	**Reference**
Oxalidaccae	Oxalis pes-caprae L.	Lemon	Leaves and stems	Diarrhea	Standard infusion taken orally	(Deeb, Knio, Shinwari, Kreydiyyeh, & Baydoun, 2013)

Zingiberaceae	Zingiber officinale roscoe	Ginger	Roots	Increasing sperm number, slowing ejaculation	Standard infusion taken orally	(Deeb, Knio, Shinwari, Kreydiyyeh, & Baydoun, 2013)
				Ameliorate hyperlipidemia, hyperglycemia, oxidative stress, and inflammation		
Lamiaceae	Rosmarinus officinalis L.	Rosemary	Leaves and shoots	Antioxidant, antimicrobial cholesterol reduction, memory and brain cells stimulant, anemia, diabetes	Decoction of dried leaves in water	(Deeb, Knio, Shinwari, Kreydiyyeh, & Baydoun, 2013) (Rašković, Milanović, Pavlović, Ćebović, Vukmirović, & Mikov, 2014)
Theaceae	Camellia sinensis	Green tea	Leaves and shoots	cancer chemoprevention, hypercholesterolemia, artherosclerosis, Parkinson's disease, Alzheimer's disease, and other aging-related disorders	Decoction of dried leaves in water	(Zaveri, 2006)
Geraniaceae	Pelargonium graveolens	Rose-scent Geranium	Leaves and shoots	Diabetes, intestinal cramps	Standard infusion taken orally	(Deeb, Knio, Shinwari, Kreydiyyeh, & Baydoun, 2013)

Lauraceae	Cinnamomum verum	Cinnamon	Bark and leaves	Anti-inflammatory properties, anti-microbial activity, reducing cardiovascular disease, boosting cognitive function and reducing risk of colonic cancer	Decoction of dried leaves in water	(Ranasinghe, Pigera, Premakumara, Galappaththy, Constantine, & Katulanda, 2013)
Asterceae	Matricaria chamomilla L.	Chamomile	Flowers, shoots, and leaves	Relaxant, headache, uterine cramp, hair dye, hoarseness, insomnia	Standard infusion taken orally	(Deeb, Knio, Shinwari, Kreydiyyeh, & Baydoun, 2013)
Zingiberaceae	Elettaria cardamomum	Cardamom	Seeds	asthma, teeth and gum infections, cataracts, nausea, diarrhea, cardiac, digestive and kidney disorders	Standard infusion taken orally	(Ashokkumar, Murugan, Dhanya, & Warkentin, 2020)
Apiaceae	Pimpinella anisum L.	Aniseed	Seeds	Diuretic, flatulence, stomachache, asthma, nerve relaxant	Standard infusion taken orally	(Deeb, Knio, Shinwari, Kreydiyyeh, & Baydoun, 2013)
Lamiaceae	Mentha longifolia	Mint	Leaves	Gall bladder, nutritive, digestive system	Standard infusion taken orally	(Deeb, Knio, Shinwari, Kreydiyyeh, & Baydoun, 2013)
Mint	Salvia officinalis	Sage/ Salvia	Leaves	Colds and abdominal pain	Decoction of dried leaves in water	(Gali-Muhtasib, Hilan, & Khater, 2000)

Lauraceae	Laurus nobilis	Bay leaf	Leaves	Anti-calcification, anti-toxin	Decoction of dried leaves in water	(Deeb, Knio, Shinwari, Kreydiyyeh, & Baydoun, 2013)

2.6 Yerba Mate tablets

Aqueous extract solutions of *I. paraguariensis* contain several bioactive compounds that have a great beneficial impact on the drinkers' health whether ingested in the form of decoction or infusion. Polyphenols are of the greatest interest regarding their antioxidant activity. Researchers have been trying to make use of these aqueous extracts for the development of natural products in order to protect the humans' biological systems against oxidative stress-mediated damages. However, since the target compounds are aqueous extracts, problems with stability have been always faced (Oliveira, Bott, & Souza, 2006). The phenolic compounds present in yerba mate are very unstable. They can be directly affected by oxidation and thermal degradation in aqueous media (Buchner, Krumbein, Rohn, & Kroh, 2006).

In order to solve the stability problem, it has been found that spray- drying is the most suitable technique (Masters, 1991). A protocol has been designed to create, in semi-industrial scale, which is the *I. paraguariensis* spray-dried powder (SDP). This technique is used to check whether it will withstand the thermal and photo- stability of the main polyphenol constituents. The spray-drying process showed stability. The designed SDPs are spherical particles with a mean size of 19.6mm, smooth surface, and good flow properties. Four polyphenol compounds that characterize *I. paraguariensis* have been detected that are: neochlorogenic acid, chlorogenic acid, cryptochlorogenic acid, and rutin. The photo-stability test showed that the polyphenols present in the SDP proved to be stable against ultraviolet C

radiation for 48 hours. The thermal stability test showed that the polyphenols were hygroscopic and responsive to temperature (40ºC) under an atmosphere of high relative humidity (75%) for 4 months, especially when the SDP was conditioned in permeable flasks. Hence, anytime SDP yerba mate pills should be created, one must take into consideration that heat and residual moisture content play an important role in the stability of the polyphenols. SDP must be carried out in humid tight packages under low temperatures (Yatsu, Borghetti, & Bassani, 2011).

2.7 Effect of yerba mate and medicinal plants on health

Adding medicinal plants to mate and tereré (cold mate beverage) can promote wellbeing in respect to the illnesses that are treated. Mate is a vehicle to ingest hot remedies (for “cold” syndrome) and plants which treat women’s reproductive health. Refreshing plants (for heat flashes) are always prepared with tereré. Most species used for urinary infections and kidney problems are used with tereré too. However, sometimes the linkage among medicinal plants to the hot or cold beverage is due to their flavor and taste. Paraguayans have indicated that they prefer to have bitter and sharp flavored plants as mate, whereas sour tasting plants are used only with tereré. The plants are used for a wide array of medicinal categories from which the digestive system and humoral medicine show why such health problems have been treated with the Arabian folk medicines or the medicinal plants. Recently, new chronic health conditions such as diabetes, hypertension, and high levels of cholesterol have been treated with a large number of medicinal plants species and yerba mate polyphenols. Therefore, the old way of treating illnesses through the traditional medicinal plants have proved that it's effective on the new chronic diseases. Newly integrated medicinal plants, such as *Moringa*

oleifera or *Annona muricata*, are applied predominantly or exclusively with the mate beverage (Kujawska M. , 2018).

III. Materials and Methods

The purpose of this study is to identify and examine the effect of yerba mate and medicinal plants on the drinkers' health. This chapter includes a description of the research methodology.

The relationships among research questions, hypotheses, and instruments were defined. The target population consisted of Lebanese that are yerba mate drinkers and nondrinkers living in the mountains' villages and the suburbs, and in the cities. The identified variables were divided into dependent and independent variables. The independent variables were Yerba mate drinker (YD), yerba mate nondrinker (YND), yerba mate drinker with medicinal plant (YDM), medicinal plant drinker only (MD), and the living place (L). The dependent variables were health of yerba mate drinkers (HYD) and health of nondrinkers (HYND). The items of health of mate drinkers and nondrinkers as well as the medicinal plants, were defined and grouped into one factor.

Kujawska (2018) study was used to measure indicators of yerba mate drinkers' health compared to nondrinkers' health with and without the ingestion of medicinal plants. The instruments to measure yerba mate drinker, yerba mate nondrinker, medicinal plant drinker, and health indicators have been developed and improved theoretically and empirically and the reliability measures for this study were calculated using Cronbach's alpha.

The researcher reached out to the participants by sending the questionnaire to the Lebanese living in the mountains' villages and suburbs and the in the cities in the form of a Google Form to stick with coronavirus pandemic regulations. The researcher collected the questionnaire with the help of colleagues at Notre Dame University (Main and Shouf Campuses) while following judgmental sampling. Judgmental sampling is a form of convenience sampling in which the population elements are purposively selected based on the

judgment of the researcher (Malhotra, 1999). Principal component analysis was selected for conducting analysis using SPSS 21 to reduce the data, followed by a conceptual association to study the relationships among all variables.

3.1 Research Relationships

To identify and examine the effect of yerba mate and medicinal plants on the drinkers' health, we hypothesize that yerba mate has a significant role in the treatment of illnesses, and that yerba mate nondrinkers' health varies to that of drinkers'. In addition, we checked whether yerba mate combined with medicinal plants positively influences the individuals' health, and if medicinal plants positively influence the health of yerba mate nondrinker. Also, we hypothesized residence impacts the health of yerba mate drinkers and nondrinkers.

3.2 Population

The target population for this study included Lebanese living in two different areas in Lebanon that are: the cities and the mountains that include the villages and the suburbs during July 2020 (N=200). 65 percent of respondents (130 respondents) lived in the mountain and 35 percent (70 respondents) lived in the city.

Participants in the study were chosen to be from two different areas in Lebanon due to the history and traditions mentioned in the literature review behind yerba mate being a drink frequently ingested by Lebanese living in the rural areas or the mountain's villages and the suburbs, whereas in the cities yerba mate is occasionally drank. Both, males and females of

all ages drink yerba mate in Lebanon and this could be due to cultural norms, for health reasons or other, which has been also described in the literature review.

3.3 Variables

As mentioned earlier, the study identifies two dependent variables that are the health of yerba mate drinkers and health of yerba mate nondrinkers. These two variables included the following items: diabetes, heart health, digestion, cold symptoms, ulcers, inflammation reduction, stress reduction, nausea, immunity booster, menstruation problems, musculoskeletal, antioxidants supplement, neurodegenerative diseases (Alzheimer and Parkinson), weight- loss, cancer, lower cholesterol, and other health role. They were defined and grouped into one factor. In addition, five independent variables were specified. The first independent variable was the yerba mate drinker which represents the respondents that frequently ingest yerba mate. The second independent variable was the non yerba mate drinker that stands for the respondents that don't ingest yerba mate. Yerba mate drinker with medicinal was the third independent variable representing the respondents that add medicinal plants to their yerba mate beverage. The fourth was the medicinal drinkers that are the respondents that only drink medicinal plants in the form of tea. The last one was the residence which included the respondents that are living in Lebanon's cities and those living in the mountain's villages and the suburbs.

3.3.1 Medicinal plants

13 medicinal plants were selected that are mostly consumed by the Lebanese culture. The medicinal plants mentioned in the questionnaire were either added to the yerba mate beverage

or drank in the form of tea by yerba mate nondrinkers, based on the respondents' preference. ref in lit review. The medicinal plants included in our study were: lemon, ginger, rosemary, green tea, rose- scent geranium, cinnamon, chamomile, cardamom, aniseed, mint, sage/ salvia, bay leaf, and the other medicinal plants option were participants can add additional plants that weren't mentioned in the options.

3.4. Questionnaire Development

A questionnaire was designed to provide information to test relationships among dependent and independent variables. It was approved by the Institutional Review Board (IRB).

The visual layout of the questionnaire was simple. A one-page cover letter was designed to introduce the researcher, explain the background and purpose of the study, address confidentiality issues, emphasize voluntary participation, offer information on how to contact the researcher for questions, and include procedures for submitting the questionnaire.

The questionnaire included 11 questions that addressed gender, age, residential area, the consideration of mate as a medicinal plant, yerba mate ingestion, the reasons for drinking mate, the addition of medicinal plants types, the effect of yerba mate on health, and whether or not the ingestion of yerba mate serves as a vehicle for the intake of medicinal plants. For health as a dependent variable for both yerba mate drinkers and nondrinkers, 17 items were developed (diabetes, heart health, digestion, cold symptoms, ulcers, inflammation reduction, stress reduction, nausea, immunity booster, menstruation problems, musculoskeletal, antioxidants supplement, neurodegenerative diseases (Alzheimer and Parkinson), weight-loss, cancer, lower cholesterol, and other health role) based on the theoretical framework inspired by the initial referred article (Kujawska M. , 2018) and other studies that tackled the

effect of mate on a certain specified disease that were all mentioned in the literature review. For medicinal plants as an independent variable, 13 items based on the theoretical framework (Kujawska M. , 2018) were developed inspired from (Deeb, Knio, Shinwari, Kreydiyyeh, & Baydoun, 2013) that are: lemon, ginger, rosemary, green tea, rose- scent geranium, cinnamon, chamomile, cardamom, aniseed, mint, sage/ salvia, bay leaf, and the other medicinal plants option were participants can add additional plants that weren't mentioned in the options. Add the variables

4 pilot studies were made. Two participants that are colleagues of the graduate student at the faculty, and two random Lebanese one living in the mountain and the other in the city completed the questionnaire. Few adjustments were made regarding definition of terms. The pilot study showed that the instructions given to participants were comprehensible, the questionnaire was reliable and valid, and the design of hypotheses was eligible.

The questionnaire was sent to students at NDU Main and Chouf campuses and to Lebanese living in the mountain and the city in order to have participants from rural and urban areas and from various age groups. Both males and females filled out the questionnaire. It was sent to the participants through WhatsApp and Email while explaining to those who asked on the phone the purpose of the study and clarifying the terminology or any misleading information. Judgmental sampling was followed. Mention in data analysis or in the design of quest first. The researcher intentionally tried to target the population who drank mate via Email and selected WhatsApp groups. However, the researcher couldn't control the responses as the questionnaire was shared via different WhatsApp groups. The total of participants that completed the questionnaire was 200.

3.5 Validity and Reliability

3.5.1 Validity

As discussed earlier, the questionnaire for this study was adapted from 3 models: (Kujawska M. , 2018), (Deeb T. , Knio, Shinwari, Kreydiyyeh, & Baydoun, 2013), and (Heck & Mejia, 2007). Initially, the questionnaire was submitted to 4 participants to determine whether the questions were clear, understandable, and in a logical order (face validity).

Moreover, the questionnaire was reviewed and approved by the IRB (content validity).

Finally, factorial validity was established. This validity indicates that the factor structure of the questionnaire makes intuitive sense. Using SPSS 21, factor analysis was performed and correlated questions were re-coded into uncorrelated variables called factors (factorial validity) (Field, 2003).

3.5.2 Reliability

To assess the reliability of for the questionnaire, Cronbach's alpha was calculated using SPSS. Cronbach's alpha used to quantify the internal consistency and reliability of items in clinical research and beyond. Mathematically, it's an adjusted proportion of total variance of the item scores explained by the sum of covariances between item scores, and thus ranges between 0 and 1 if all covariance elements are non-negative (Heo, Kim, & Faith, 2015). The items of the questionnaire showed a high internal consistency and reliability as Cronbach's alpha was greater than 0.70. Cronbach's alpha was done on: medicinal plants drank as tea,

medicinal plants added to yerba mate, health of mate drinkers, and health of mate nondrinkers (table 3).

1. The variable of those that drink yerba Mate with medicinal plants (YDM) which include lemon, ginger, rosemary, green tea, rose- scent geranium, cinnamon, chamomile, cardamom, aniseed, mint, sage/ salvia, bay leaf, and other medicinal plants the participants ingest.
2. Health of yerba mate drinkers (HYD) included diseases and conditions that are diabetes, heart health, digestion, cold symptoms, ulcers, inflammation reduction, stress reduction, nausea, immunity booster, menstruation problems, musculoskeletal, antioxidants supplement, neurodegenerative diseases (Alzheimer's and Parkinson's diseases), weight- loss, cancer, lower cholesterol, and other additional diseases the participants may list.
3. Medicinal plants drank in the form of tea (MD): lemon, ginger, rosemary, green tea, rose- scent geranium, cinnamon, chamomile, cardamom, aniseed, mint, sage/ salvia, bay leaf, and other medicinal plants the participants ingest.

4. Health of yerba mate nondrinkers (HYND): diabetes, heart health, digestion, cold symptoms, ulcers, inflammation reduction, stress reduction, nausea, immunity booster, menstruation problems, musculoskeletal, antioxidants supplement, neurodegenerative diseases (Alzheimer's and Parkinson's diseases), weight- loss, cancer, lower cholesterol, and other additional diseases the participants may list (table 3).

Table 3: Reliability statistics showing significant cronbach's alpha level for the studied variables

Variable		Reliabilty (Cronbach's Alpha)
Yerba mate drinkers	Health of yerba mate drinkers (HYD)	0.830
	Mate drinker with Medicinal Plants (YDM)	0.727
Yerba mate nondrinkers	Health of yerba mate nondrinkers (HYND)	0.827
	Medicinal plants drank in the form of tea (MD)	0.880

3.6 Data Analysis

This study seeks to identify and examine the effect of yerba mate on the drinkers' health, the health of those who drink yerba mate with medicinal plants, the health of mate non-drinkers who take medicinal plants as tea, and the role of the living place. Principal Component Analysis Model was selected as the basic model for conducting analysis by employing SPSS (Statistical Package for the Social Sciences). This model is a data reduction technique that creates components or factors that allow the interpretation of large series of data into components that can be meaningfully important. The model conceptually helped the researcher better understand the mechanism by which yerba mate with and without the addition of medicinal plants influenced health.

3.6.1 Variable Identification

In order to investigate the relationships among yerba mate ingestion, residence, health, and medicinal plants, the first step was to identify each set of variables. The Principal Component Analysis Model was used to redefine these 7 variables.

There are two basic types of factor analysis: exploratory and confirmatory. Exploratory factor analysis (EFA) is used when researchers have no prior assumption about the number of factors necessary to explain the interrelationships among a set of characteristics, indicators, or items. Another is confirmatory factor analysis (CFA), which purposely assesses the extent to which the hypothesized model of a set of identified factors fits the data (Gao, 2011).

In this study, yerba mate practices were categorized based on two different standards which included factors as participants that are mate drinkers and those that are non-yerba mate drinkers. Medicinal plants indicators were grouped into one group and then each type or option from the medicinal plants' section was tackled as a single factor. Also, health indicators were grouped into one group and then each disease was tackled as a single factor. Therefore, it is necessary to explore the factor structure of yerba mate ingestion by conducting an EFA. A CFA was then conducted to determine whether the factor structure generated from the EFA required modification.

SPSS identifies PCA as Factor Analysis. However, the difference between PCA and Factor Analysis is in PCA, data is reduced to explain total variance or total variability associated with each variable in the analysis. In Factor Analysis, (also known as Common Factor Analysis) the only percentage of variance included into the model is the variance that is

shared between the variable under study and the rest of variables included in the analysis. The difference is obvious in the correlation matrix where diagonal elements in PCA are equal to

The researcher conducted an EFA to identify a viable factor structure for dependent and independent variables. EFA was conducted to determine the factor structure of the 17 items of health items that are common for yerba mate drinkers and nondrinkers as a dependent variable and 13 items of the medicinal plants types as an independent variable using the following guidelines:

- Principal components was chosen as the extraction model
- Varimax rotation was selected as it ensures that factors grouping are not correlated
- Listwise missing values was used
- Factors were extracted based on Eigenvalues >1
- Statistically significant components tested by Bartlett's test of sphericity were considered
- KMO (Kaisen-Meyer-Olkin) measure of sampling adequacy was considered where values >0.7 showed positive correlations and justified performing component analysis
- ± 0.40 was the factor loading standard

Items with absolute primary factor loadings ≥ 0.40 were retained. Items not meeting this criterion were removed one item at a time. Factor analyses iterations were repeated until a solution was attained in which all the items included in the analysis met all criteria. The solution is presented in the following section, the results.

3.6.3 Conceptual Association between the Different Variables

Association was done to test relationships between the variables. SPSS 21 was used where Pearson Correlation Coefficient was chosen.

Hence, three-step analyses were taken to complete this study: the first step involved descriptive analysis to describe the characteristics of the respondents as well the distribution of responses to the items describing yerba mate, medicinal plants, and health; the second step was factor analysis to identify the factor structures of the variables; and the third step involved the use of correlation to examine the relationships among these variables.

IV. Results

The purpose of this study is to examine the relationships among yerba mate and medicinal plants, living place, and health. This chapter includes two sections, data analysis process and summary of findings. In this chapter, the results of the statistical data analyses are reported as proposed in the previous chapters to answer the five research questions and to test the five hypotheses.

4.1 Data Analysis Process

4.1.1 Descriptive Analysis

The descriptive statistics among each item included gender, age, residence, considering yerba mate as a medicinal plant, usage of yerba mate as a vehicle for the ingestion of medicinal plants, the percentage of mate drinkers as compared to nondrinkers, and the reasons that render mate drinkers drink this beverage (cultural, considering it as a medicinal plant, for health reasons, boosts energy, and source of comfort).

All frequencies and percentages were presented in table 4. Results show the majority of respondents were females (67.5%), with age ranging from 16 to 74 and the median was 24 as shown in figure 2. Most of the participants (65%) were living in the mountains.

Table 4: Gender and residence descriptives showing the frequency and percentage of each variable

Variable		Number of Respondents	Percentages (%)
Gender	Males	65	32.5%
	Females	135	67.5%

Residence	Mountain	130	65%
	City	70	35%

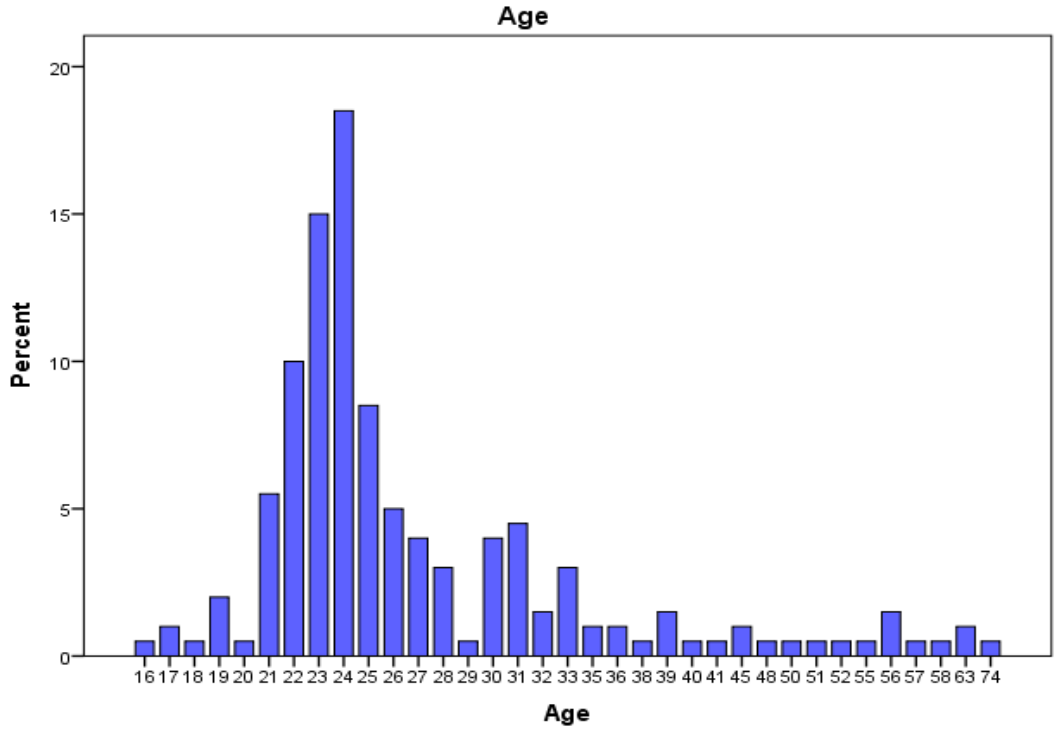

Figure 2: Respondents age chart

Females and males from all ages living in the mountains and cities were asked about their different perceptions of yerba mate as a medicinal plant and whether this plays a role in the ingestion of other medicinal plants in addition to other reasons that render them ingest yerba mate beverage. Table 5 shows the percentages of the descriptive data. 70.5% of the respondents were yerba mate drinkers. In addition, 45.5% of the respondents perceive yerba mate as a medicinal plant and 36.5% consider yerba mate as a vehicle to ingest other medicinal plants. Yerba mate drinkers chose more than one reason that render them drink this

beverage where 14% drink it for its medicinal virtues, 57% for cultural reasons, 14.5% for health purposes, 32% consider it as an energy booster, and 49% mentioned that yerba mate gives them a source of comfort (Figure 3).

Table 5: Descriptive statistics of the participants that consider yerba mate as medicinal plant, yerba mate as a vehicle to ingest medicinal plants, yerba mate drinkers, and the reasons that make respondents drink yerba mate (cultural, for medicinal reasons, for health reasons, energy booster, and as a source of comfort).

Descriptive factor		Frequency	Percentage
Yerba mate is a medicinal plant	Yes	91	45.5%
	No	109	54.5%
Mate drinker	Yes	141	70.5%
	No	59	29.5%
Yerba mate as a vehicle to ingest medicinal plants	Yes	73	36.5%
	No	127	63.5%
Reasons for drinking yerba mate			
Medicinal	Yes	28	14%
	No	172	86%
Cultural	Yes	114	57%
	No	86	43%
Health	Yes	29	14.5%
	No	171	85.5%
Energy booster	Yes	64	32%
	No	136	68%
Comfort	Yes	98	49%
	No	102	51%

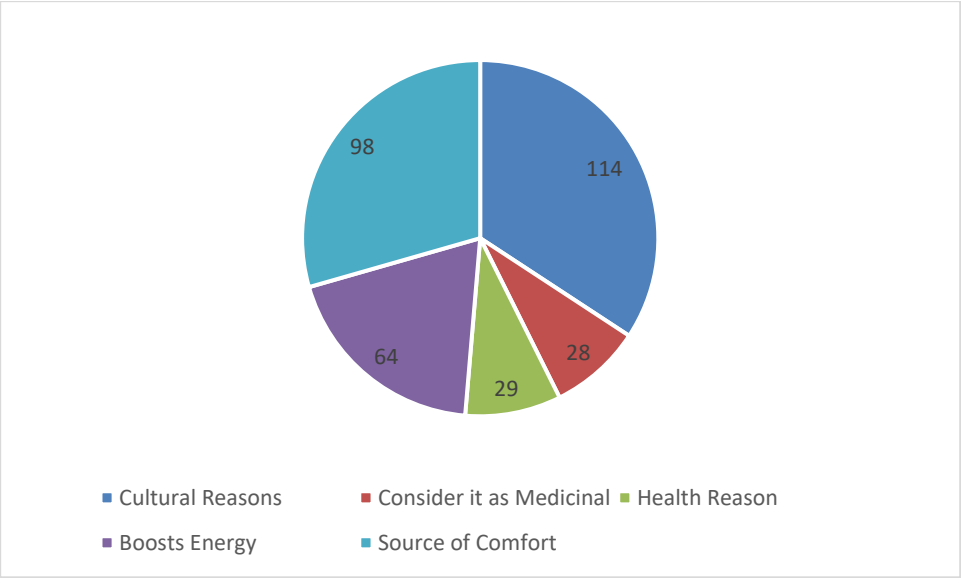

Figure 3: Descriptive statistics of Reasons of drinking yerba mate

Table 6 represents the medicinal plants that the respondents mostly add to their yerba mate beverage where lemon, ginger, rosemary, cardamom, and rose- scent geranium showed the highest frequencies, for yerba mate drinkers. The same medicinal plants showed different frequencies for yerba mate nondrinkers that ingest them in the form of tea, where lemon, ginger, green tea, aniseed, mint, and chamomile showed the highest frequencies.

In addition, this table shows the illnesses that the respondents think are treated or lessened by yerba mate mixed with medicinal plants. Digestion, weight loss, lower cholesterol, stress reduction, cold symptoms, immunity booster, and antioxidant had the highest frequencies. On the other hand, the conceptual health benefits for nondrinkers differed where digestion, stress reduction, cold symptoms, and immunity booster had the highest frequencies.

Table 6: The frequency of drinking medicinal plants added to yerba mate or in the form of tea for nondrinkers and the conceptualized health benfits of respondents

Medicinal Plants	**Yerba Mate Drinkers**	**Yerba Mate Nondrinkers**
Lemon	104	25
Ginger	34	32
Rosemary	31	13
Green Tea	7	45
Rose- scent Geranium	29	2
Cinnamon	7	21
Chamomile	6	22
Cardamon	64	4
Aniseed	3	40
Mint	7	37
Sage/ Salvia	7	14
Bay leaf	5	6
Health Benefits		
Diabetes	22	6
Heart Health	23	7
Digestion	85	20
Cold Symptoms	42	29
Ulcers	4	1
Inflammation Reduction	8	7
Stress Reduction	84	29
Nausea	20	10
Immunity Booster	32	14

Menstruation Problems	21	7
Musculoskeletal	5	0
Antioxidants Supplement	27	8
Neurodegenerative diseases	4	2
Weight- Loss	53	10
Cancer	5	4
Lower Cholesterol	21	6

4.1.2. Factor Analysis

The CFA yielded one factor solution for each dependent variable studied.

Health diseases related items variables were extracted into 17-item statistically significant component.

4.1.2.1 Health of Mate Drinker (HYD) and Health of Mate Nondrinkers (HYND) as variables

Factor analysis was used to reduce a large number of variables into fewer numbers of factors that are statistically significant. For the health of yerba mate drinker, two items were removed for not meeting the criteria mentioned above. These included the "other health role option" and "stress reduction" where respondents can choose to add an additional disease or health role of yerba mate. According to this study, and based on the yerba mate drinkers' responses, it has been found that yerba mate can lower the occurrence of diabetes, promote a better heart health, ease digestion, relieve cold symptoms and ulcers irritations, lessen nausea, boosts immunity, mitigate menstruation and musculoskeletal problems, supplies the body with antioxidants, lessen the happening of neurodegenerative diseases (Alzheimer and Parkinson), aids in weight loss and cancer prevention, as well as lowering the cholesterol level. The numbers are all significant since significance level was zero. This reveals that stress cannot be regulated by mate as perceived by the respondents, but only through adjusting the lifestyle and at most, taking prescribed medications (Babatunde, 2013). Also, based on the criteria mentioned above, for the health of yerba mate nondrinkers, seven items were removed out of the table for not meeting the qualifications which are: heart health, digestion, cold symptoms, ulcers, immunity booster, musculoskeletal, and menstruation problems. Most of the items that were removed can originally be treated or their symptoms can be relieved through the

ingestion of hot beverages. This has always been the first resort before taking any kind of medication (Fardet & Boirie, 2014) (table 7)

Table 7: Health of yerba mate drinkers and nondrikers Component Matrix

Component Matrix		
	Health of Mate Drinker (HYD)	Health of Mate Nondrinkers (HYND)
Diabetes	0.54	0.546
Heart Health	0.577	0.064
Digestion	0.453	0.119
Cold Symptoms	0.464	0.293
Ulcers	0.542	0.036
Inflammation Reduction	0.749	0.469
Stress Reduction	0.37	0.448
Nausea	0.597	0.454
Immunity Booster	0.519	0.398
Menstruation Problems	0.537	0.031
Musculoskeletal	0.756	0.305
Antioxidants Supplement	0.601	0.41
Neurodegenerative diseases (Alzheimer and Parkinson)	0.78	0.526
Weight- Loss	0.563	0.506
Cancer	0.786	0.531
Lower Cholesterol	0.55	0.463

Other health role	-0.07	-0.04

4.1.2.2. Mate drinker with Medicinal Plants (YDM) and Medicinal plant drinkers in the form of tea (MD) as variables

The results indicate that the respondents mainly add to their yerba mate beverages rosemary, chamomile, and aniseed. All the rest were removed due to the criteria that have been assigned for the study. As for chamomile, traditionally it has been used as an anti-inflammatory, antioxidant, mild astringent and healing medicine (Srivastava, Shankar, & Gupta, 2010). Rosemary has been used for various medicinal purposes, as a stimulant and mild analgesic, an effective herb for treating headaches, poor circulation, inflammatory diseases, and physical and mental fatigue, as well as a choleretic and hepatoprotective agent in folk medicine (Rašković, Milanović, Pavlović, Ćeković, Vukmirović, & Mikov, 2014). Aniseed had several uses in the traditional Arabian folk medicine as analgesic in migraine and as carminative, aromatic, disinfectant and diuretic. Recent studies revealed anise as a potent antiperoxidative and antidiabetic agent that can be used in the drug industry (Sun, Shahrajabian, & Cheng, 2019). In addition, the results show that lemon, ginger, rosemary, green tea, cinnamon, chamomile, aniseed, mint, and sage are mostly drank as tea, which can be linked to the kinds of herbs that were originally present in the Arabian folk medicine and that have been continuously ingested and used in drugs by several generations (table 8).

Table 8: Yerba mate with medicinal plants component matrix

Medicinal Plant	With yerba mate	in the form of Tea
Lemon	0.199	0.59
Ginger	0.362	0.63
Rosemary	0.406	0.47
Green Tea	0.275	0.647

Rose- scent Geranium	0.286	0.085
Cinnamon	0.191	0.442
Chamomile	0.436	0.626
Cardamon	0.23	0.108
Aniseed	0.405	0.418
Mint	0.294	0.696
Sage/ Salvia	0.181	0.482
Bay leaf	0.246	0.217
Other	0.026	0.01

Kaiser-Meyer-Olkin (KMO) Test is a measure of how suited the data is for Factor Analysis. The test measures sampling adequacy for each variable in the model and for the complete model. The statistic is a measure of the proportion of variance among variables that might be common variance. Hence, KMO and Bartlett's test of sphericity indicate that correlation matrices are suitable for factor analysis. The results show that KMO measure of sampling adequacy for the health of yerba mate drinkers was 0.714 which means high sample adequacy and the chi- square value was 1523.884 which shows high correlation between data, thus there is strong relationship between drinking mate and health of drinkers which was statistically significant. Regarding the health of yerba mate nondrinkers KMO measure of sampling adequacy for the health of yerba mate nondrinkers was 0.725 which means high sample adequacy and the chi- square value was 1434.993 which shows high association between data.

Significance was shown for the health of yerba mate drinkers that add medicinal plants to their beverages where the KMO measure of sampling adequacy was 0.698 and the chi- square was 585.776 indicating high correlation between data. The last KMO value was 0.821 for the yerba mate nondrinkers that drink medicinal plants in the form of tea which shows high adequacy and the chi- square value was 1245.077 which shows high correlation between

data, which can reflect a strong relationship between drinking medicinal plants as tea and health (table 9).

Table 9: Kaiser-Meyer-Olkin & Bartlett's Test showing Kaiser-Meyer-Olkin measure of sampling adequacy, Chi- square, and significance for the health of yerba mate drinkers, health of yerba mate nondrinkers, health of yerba mate drinkers with the addition of medicinal plants, and the medicinal plants drank in the form of tea.

KMO and Bartlett's Test	**Health of yerba mate drinkers**	**Health of yerba mate nondrinkers**	**Health of yerba mate drinkers + medicinal plants**	**Health of medicinal plants drinkers in the form of tea**
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.714	0.725	0.698	0.821
Approx. Chi-Square	1523.884	1434.993	585.776	1245.077
Significance	0	0	0	0

4.1.3 Conceptual Association between the Different Variables

Correlation was used in SPSS 21 to test relationships between the variables.

4.1.3.1 Association between health (HYD) and yerba mate drinkers (YD)

The association between health of yerba mate drinkers (HYD) and yerba mate drinkers (YD) was correlated using SPSS 21, and showed a significant positive correlation (0.373) for conceptual beliefs of health benefits for drinking yerba mate (table 10).

Table 10: Association between health and yerba mate drinkers

Correlations

		Drink	Health od Drinkers
Drink	Pearson Correlation	1	.373**
	Sig. (2-tailed)		.000
	N	200	200
Health of Drinkers	Pearson Correlation	.373**	1
	Sig. (2-tailed)	.000	
	N	200	200

**. Correlation is significant at the 0.01 level (2-tailed).

4.1.3.2 Difference between the health of yerba mate drinkers (HYD) to that of nondrinkers (HYND)

The association between health of drinkers (HYD) and nondrinkers (HYND) was analyzed using SPSS 21 through correlation between the extracted factors. The factors extracted, showed negative correlation with significant results. Therefore, nondrinkers' health is not affected by not drinking yerba mate (table 11).

Table 11: Comparison between the health of yerba mate drinkers and health of yerba mate nondrinkers

Correlations

		REGR Health	REGR T Health
REGR Health	Pearson Correlation	1	-.205**
	Sig. (2-tailed)		.004
	N	200	200
REGR T Health	Pearson Correlation	-.205**	1
	Sig. (2-tailed)	.004	
	N	200	200

**. Correlation is significant at the 0.01 level (2-tailed).

4.1.3.3 Association between health of drinkers (HYD) with addition of medicinal plants to mate (YDM) and that of the nondrinkers (HYND) associated to medicinal plants (MD)

The association between health of yerba mate drinkers (HYD) and addition of medicinal plants to yerba mate (YDM) was correlated using SPSS 21. The factors extracted, as discussed before, showed positive correlation (0.659) which was statistically significant. In other words, adding medicinal plants to yerba mate positively affects health. In addition, the association between health of yerba mate nondrinkers (HYND) and ingestion of medicinal plants in the form of tea (MD) was correlated using SPSS 21 through correlation. The factors extracted showed positive correlation (0.501) which was statistically significant. Hence, medicinal plants drank in the form of tea also positively affects the health of those who drink them (table 12).

Table 12: Correlation between the health of yerba mate drinker with the addition of medicinal plants and the nondrinkers that drink medicinal plants in the form of tea

Correlations

		Health of Yerba Mate Drinkers	Medicinal with Yerba Mate	Health of Yerba Mate Nondrinkers	Medicinal with Tea
Health of Drinkers	Pearson Correlation	1	.659**	1	.501**
	Sig. (2-tailed)		.000		.000
	N	200	200	200	200
Medicinal with Mate	Pearson Correlation	.659**	1	.501**	1
	Sig. (2-tailed)	.000		.000	
	N	200	200	200	200

4.1.3.5 Correlation between health of drinkers and nondrinkers to living place

The relationship between health of both mate drinkers (HYD) and nondrinkers (HYND) (as dependent variables) and residence or living place L (as an independent variable) was analyzed using SPSS 21 through correlation. The factors extracted, as discussed before, didn't show a significant correlation where the significance of the health variable for drinkers was 0.575 and for nondrinkers were 0.229. The correlation is significant at the 0.01 level (2-tailed) (table 13).

Table 13: Association between health of yerba mate drinkers and nondrinkers and the living place

Correlation is significant at the 0.01 level (2-tailed)

Correlations

		Living Place	REGR Health	REGR T Health
Living Place	Pearson Correlation	1	.040	.085
	Sig. (2-tailed)		.575	.229
	N	200	200	200
REGR Health	Pearson Correlation	.040	1	-.205**
	Sig. (2-tailed)	.575		.004
	N	200	200	200
REGR T Health	Pearson Correlation	.085	-.205**	1
	Sig. (2-tailed)	.229	.004	
	N	200	200	200

4. 2 Summary of Findings

Based on factor analysis, 15 health items of mate drinkers were statistically significant as principal components that can be meaningfully important in analyzing health of mate drinkers. Those items were: diabetes, heart health, digestion, cold symptoms, ulcers, inflammation reduction, nausea, immunity booster, menstruation problems, musculoskeletal,

antioxidants supplement, neurodegenerative diseases (Alzheimer and Parkinson), weight loss, cancer, and lower cholesterol level.

In addition, 9 health items of mate nondrinkers were statistically significant as principal components that can be meaningfully important in analyzing health of mate nondrinkers. Those items were: diabetes, inflammation reduction, stress reduction, nausea, antioxidant supplement, neurodegenerative diseases, weight loss, cancer, and lower cholesterol.

Moreover, 3 types of medicinal plants were statistically significant as principal components that can be meaningfully important in analyzing mate drinker with medicinal plants. Those items were: rosemary, chamomile, and aniseed.

In addition, 9 items of the medicinal plants were mentioned to be drunk by the respondents in the form of tea that are: lemon, ginger, rosemary, green tea, cinnamon, chamomile, aniseed, mint, and sage.

It was found that correlation doesn't exist between the living place and the health of mate and drinkers and that of nondrinkers as the significance for both in correlation was greater than 0.01. The conceptual associations have revealed the findings previously mentioned that are combined in table 14.

Table 14: Summary of findings

Research Questions (RQ)	**Hypotheses (H)**	**Findings**
RQ 1: What is the role of yerba mate in the treatment of illnesses?	H 1: Yerba Mate has a significant role in the treatment of illnesses.	Yerba mate has a positive and significant role on the health of yerba drinkers.
RQ 2: What are the differences in the health of *mate* nondrinkers compared to drinkers?	H 2: Yerba Mate nondrinkers' health varies to that of drinkers'.	Mate nondrinkers' health won't get any better if they avoid frequently drinking mate for the rest of their lives.

RQ 3: What is the synergistic effect of *mate* combined with the medicinal plants?	H 3: Yerba Mate combined with medicinal plants positively influences the individuals' health.	Adding medicinal plants to yerba mate positively and significantly affects the health of yerba drinkers.
RQ 4: How do the medicinal plants affect the health of the *mate* nondrinker?	H 4: Medicinal plants positively influence the health of *mate* nondrinker.	Medicinal plants drank in tea positively and significantly influence the health of mate nondrinkers.
RQ 5: Are the health of mate drinkers and nondrinkers linked to the living place (the cities or the mountain and its suburbs) of the participants?	H 5: The living place impacts the health of yerba mate drinkers and nondrinkers.	The living place has no significant effect on either the health of drinkers or health of nondrinkers.

V. Discussion and Conclusion

*Ilex paraguariensis***,** known as yerba mate, is a native tree found in the southern region of South America, specifically in Brazil, Argentina, Paraguay, and Uruguay (Heck & Mejia, 2007). By the year 1900, yerba mate became a popular product in the Argentinian market as soon as Paraguay started to harvest the local yerba mate (Reber, 1985). In addition, it has been found that yerba mate is ingested as a hot or cold beverage as a source for caffeine intake, for it pharmacological properties, and for its social role (Burris K. , Harte, Davidson, Stewart, & Zivanovic, 2012). Yerba mate's market has reached Mount Lebanon due to the migration of the local Lebanese during the second half of the nineteenth century, since back then the area had many local, regional, and international conflicts that led to civil wars (Issawi, 1993).

Numerous active compounds have been identified. Those are the phenolic compounds that are the primary chemical constituents and the major bioactive factors of yerba mate that

are made up of benzene rings attached to hydroxyl groups. The polyphenols in yerba mate mainly are: caffeic acid, caffeine, caffeoyl derivatives, caffeoylshikimic acid, chlorogenic acid, feruloylquinic acid, kaempferol, quercetin, quinic acid, rutin, and theobromine (Burris K. , Harte, Davidson, Stewart, & Zivanovic, 2012). Studies have demonstrated that yerba mate leaves have antioxidant (Filip & Ferraro, 2003), anti-obesity (Martinet, Hostettmann, & Schutz, 1999), anti-diabetic (Lunceford & Gugliucci, 2005), digestive improvement (Martinet, Hostettmann, & Schutz, 1999) and cardiovascular properties (Bastos, De Oliveira, Matsumoto, Carvalho, & Ribeiro, 2007), and anticancer (Martinet, Hostettmann, & Schutz, 1999). The consumption of yerba mate infusion reduces LDL-cholesterol in parallel with an increase in HDL-cholesterol, as observed in studies on humans (De Morais, et al., 2009). On the other hand, Lebanon is rich with a great variety of medicinal that have been used by the locals as Arabian folk medicine and ingested in the form of tea or by adding it to food. Some of these medicinal plants are: lemon, ginger, rosemary, green tea, rose- scent geranium, cinnamon, chamomile, cardamom, aniseed, mint, sage/ salvia, and bay leaf (Deeb, Knio, Shinwari, Kreydiyyeh, & Baydoun, 2013).

However, little is known about the use of medicinal plants mixed with yerba mate in the ethnopharmacological literature and their effect on the individuals' health. Our study analyses the role of yerba mate and medicinal plants in the treatment of illnesses within Arabian folk medicine. It has been found that Yerba mate (*Ilex paraguariensis*) is considered as a medicinal plant by less than half of the local Lebanese by its own medicinal virtues living in Lebanon's cities and mountains (with its suburbs), unlike the Paraguayans that do not consider it as medicinal (Kujawska M. , 2018). This plant, however, is perceived by a fine percentage of the participants as a very important conveyor or vehicle for medicinal plants intake. In addition, the Lebanese that participated in the study identified the following medicinal plants as an addition to their hot mate beverage: rosemary, chamomile, and

aniseed. Yerba mate aids in the ingestion of medicinal plants as hot remedies for several diseases such as: chamomile, traditionally it has been used as an anti-inflammatory, antioxidant, mild astringent and healing medicine (Srivastava, Shankar, & Gupta, 2010). Rosemary has been used for various medicinal purposes, as a stimulant and mild analgesic, an effective herb for treating headaches, poor circulation, inflammatory diseases, and physical and mental fatigue, as well as a choleretic and hepatoprotective agent in folk medicine (Rašković, Milanović, Pavlović, Ćeković, Vukmirović, & Mikov, 2014). Aniseed had several uses in the traditional Arabian folk medicine as analgesic in migraine and as carminative, aromatic, disinfectant and diuretic. Recent studies revealed anise as a potent antiperoxidative and antidiabetic agent that can be used in the drug industry (Sun, Shahrajabian, & Cheng, 2019). Regarding our results, yerba mate showed that it can lower the occurrence of diabetes, promote a better heart health, ease digestion, relieve cold symptoms and ulcers irritations, lessen nausea, boosts immunity, mitigate menstruation and musculoskeletal problems, supplies the body with antioxidants, lessen the happening of neurodegenerative diseases (Alzheimer and Parkinson), aids in weight loss and cancer prevention, as well as lowering the cholesterol level. These results show that adding medicinal plants to the yerba mate beverage can serve as a hot remedy for a current disease or for prevention.

On the other hand, 9 items of the medicinal plants were mentioned to be drunk by the respondents in the form of tea that are: lemon, ginger, rosemary, green tea, cinnamon, chamomile, aniseed, mint, and sage. In addition, 9 health items of mate nondrinkers were statistically significant as principal components that can be meaningfully important in analyzing health of mate nondrinkers. Those items were: diabetes, inflammation reduction, stress reduction, nausea, antioxidant supplement, neurodegenerative diseases, weight loss,

cancer, and lower cholesterol. The results did not show any correlation between the living place and the health of mate and drinkers and that of nondrinkers.

Therefore, this traditional form of administration of medicinal plants can be a good approach for treating new health problems. The question which remains unanswered is whether spray dried yerba mate tablets mixed with spray dried medicinal plants constituents have an additive or synergetic function on the individuals' health in disease treatment.

VI. Limitations of the study

Better assumptions would be made if we put the respondents under controlled conditions for a specific period of time prior to the study, by dividing the participants into four groups that are mate drinkers, nondrinkers, addition of medicinal plants to mate, and ingesting medicinal plants in the form of tea, and then monitor their health few months later. This would have led the researcher to give more certain results. In addition, further research should be done to check for yerba mate's effectiveness when accompanied with a healthy lifestyle. Another limitation is that the results obtained cannot be a picture of the real trend of the whole country because the participants' number is not huge and also because almost all of them are placed only in very close areas in Lebanon due to the country's small area that renders the mountains very close to the cities.

Questionnaire

Assessing the Use of Yerba Mate with Other Medicinal Plants in Lebanon

1. Gender:

   __ Male

   __ Female

2. Age:

   _____

3. Do you live in the:

   __ Mountains

   __ City

4. Do you consider mate a medicinal plant?

   __ Yes

   __ No

5. Are you a Yerba Mate drinker?

__ Yes

__ No (skip questions 6,7,8,9)

6. If yes, pick from the following all the reasons that make you drink mate:

   __ Cultural

   __ Consider it as a medicinal plant

__ For health reasons

__ Boosts energy

__ Source of comfort

Other: _____

7. Which of the following medicinal plants do you add to your mate:

(Check all that apply)

__ Lemon

__ Ginger

__ Rosemary

__ Green tea

__ Rose- scent Geranium

__ Cinnamon

__ Chamomile

__ Cardamom

__ Aniseed

__ Mint

__ Sage/ Salvia

__ Bay leaf

Other: _____

8. Based on your general knowledge and the plants you've checked in number 7, mark the role of yerba mate and medicinal plants in the treatment of illnesses which render you drink them:

__ Diabetes

__ Heart Health

__ Digestion

__ Cold Symptoms

__ Ulcers

__ Inflammation Reduction

__ Stress Reduction

__ Nausea

__ Immunity Booster

__ Menstruation Problems

__ Musculoskeletal

__ Antioxidants Supplement

__ Neurodegenerative diseases (Alzheimer's and Parkinson's diseases)

__ Weight- Loss

__ Cancer

__ Lower Cholesterol

Other: _____

9. Do you consider mate as a vehicle to ingest the medicinal plants?

__ Yes

__ No

10. If you're not a mate drinker, do you take any of the medicinal plants from number 7 in the form of tea?

__ Yes,

Name please: _____

__ No

11. Did this decrease or prevent any of the illnesses mentioned in number 8?

__ Yes,

What are the diseases? _____

__ No

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