

Research Article

## Use of Citrus Limon L. (lemon) in Treating Blood Pressure Sudden Rises

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### ABSTRACT

Popularly and from different information sources it is mentioned that the *Citrus limon* L. juice is useful to lower blood pressure. This could be due to the presence of both flavonoids and vitamin C. The aim of this work was to analyze the use of *C. limon* juice in the management of blood pressure sudden rises. In order to achieve this, the chemical composition of *C. limon* fruits available at Concepción city by means of spectroscopic and chromatographic methods. In order to characterize the use of the juice, a survey was applied to 506 hypertensive patients from the Dr. Víctor Manuel Fernández Family Health Center CESFAM in Concepción city. A pilot study with five hypertensive patients was also carried out to assess the effect of the juice against a sudden rise of blood pressure. As outcomes, polyphenols present in the *C. limon* juice were identified. Among these, erioctitrin, heperidin and diosmin can be mentioned. With respect to data collected from the survey, 95.2% of the surveyed population has ever used *C. limon* juice against a sudden blood pressure rise, with an improvement in the symptoms in about 30 minutes. In the pilot study, a decrease in the blood pressure of hypertensive patients was observed. This decrease tends to be sustained over time, unlike in normotensive patients. The use of *C. limon* juice against a sudden blood pressure rise is widely rooted in popular culture and it was concluded that this juice decreases blood pressure by means of a non established action mechanism, probably related to the content of polyphenols and vitamin C. Antihypertensive effects have been attributed to these compounds

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### INTRODUCTION

Blood pressure is one of the most variable, but most regulated functions of the organism. The aim of the control is to keep a constant blood flow to the vital organs, because if there is no such flow, death is produced within seconds, minutes or days<sup>1</sup>. As vital biological parameter, blood pressure has a large number of very well synchronized systems involved in its regulation, so the amount of pressure is kept stable and with low variability<sup>1,2</sup>.

Blood hypertension (HTN) is a chronic disease of multifactor etiology that corresponds to a persistence elevation of the blood pressure above the reference limits. By convention it has it has defined as such, the systolic blood pressure greater than or equal to 140 mmHg<sup>3</sup>. There are not specific symptoms that suggest HTN. Occasionally, patients refer occipital headache, dizziness or heat. These symptoms are completely irrelevant and non-specific making the diagnosis of the disease usually incidental<sup>1,2,4</sup>. According to the 2010 Chilean National Health Survey, this disease records a prevalence of 26.9% of the Chilean population and it is presented in people aged 65 years or more. Of all people with HTN only 16.9% keep their blood pressure under control<sup>5</sup>. The importance of HTN as public health problem is due to the role presented in both cardiovascular morbidity and mortality<sup>4</sup>, such as coronary arteriosclerosis, heart failure<sup>2</sup>, stroke, coronary insufficiency, congestive heart failure and chronic renal failure, among others<sup>6</sup>. Thus, HTN is constituted into one

of the main causes of death both in Chile and also in the rest of the world<sup>7</sup>.

The main objective of the treatment of the essential HTN is reaching and keeping a blood pressure lower than 140/90 mmHg<sup>1</sup> and lower than 130/80 mmHg in patients with diabetes mellitus or with chronic renal failure<sup>2,4</sup>, in order to avoid thus cardiovascular and renal morbidity -mortality associated to this disease<sup>1,4,6</sup>.

Among the health problems that a hypertensive patient might face, sudden blood pressure rises must be taken into account. In this case, the patient may choose to attend to a public urgency health system or performing self-care measures.

These self-care measures correspond to healing practices established within the family either by its own initiative or by some close relatives of the patient, without the mediation of a health professional<sup>8</sup> and carried out before a disease or illness. Among these, hygienic and/or dietetic measures, self-medication with drugs and/or herbs, and ritual treatments can be mentioned. Even doing nothing must be considered as option<sup>9</sup>.

Medicinal plants have been used to alleviate the ills of mankind since remote times. Empirical knowledge about these plants and their healing effects have been described for millennia, becoming an integral part of systems and healing traditions because of their broad therapeutic margin, readily available, simple management and multiple benefits<sup>10</sup>.

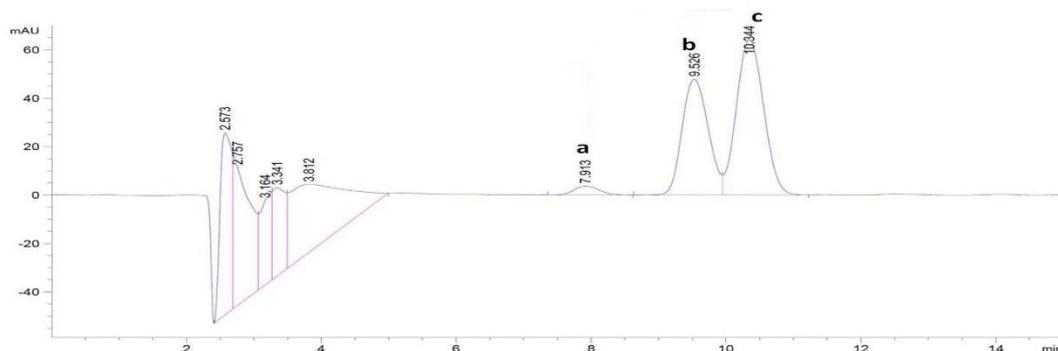


Fig. 1: *C. limon* juice chromatogram a: Diosmin, b: Hesperidin and c: Eriocitrin

Currently, there are studies that support the popular uses of many commonly used medicinal plants. However, there are other uses rooted in the popular belief, with no scientific backing. These beliefs would be worthy of analysis. This is the case of *C. limon* L. Burm. F. This species correspond to a citric tree belonging to the *Rutaceae* family and known with the common name of lemon tree. A variety of medicinal and nutritional properties are due to this fruit. Among the different uses mentioned for *C. limon*, the treatment of HTN must be noted. In the revised literature, the administration of *C. limon* juice during long periods for the prevention or reduction of blood pressure against a sudden rise is mentioned. In turn, to its content of vitamin C and the variety of flavonoids, important biological actions for health, including HTN are attributed to this fruit<sup>11,12</sup>.

On the other hand, both amount of *C. limon* juice to be used and the administration way are varied and no unique treatment exists. In addition, in the revised literature at the time of starting this study, no clinical study that proves this effect or the component or components that would be responsible for that action are mentioned. Hence, it becomes necessary to study the use of *C. limon* juice in the management of blood pressure sudden rise.

## MATERIALS AND METHODS

**Vegetal material obtaining:** *C. limon* fruits were obtained at the Vega Monumental market, in the “Señora María fruits and vegetables”, located in the Lorenzo Arenas sector in the Concepción city.

**Chemical analyses**

*C. limon* juice obtaining

*C. limon* fruits were washed to eliminate any dirt that may be present on the surface. Then the fruits were squeezed in a home citrus juicer and the obtained juice was filtered through a sieve directly into a beaker in order to remove the pulp. The obtained juice was partitioned in 15 mL falcon type tubes (Biologix research company, USA) and centrifuged for six minutes at 1000 rpm (PLC-05, Arquimed, Chile). The whole process was carried out at room temperature. The supernatant was removed with the aid of a micropipette (DP03711, SUDE lab S.A, 5000 $\mu$ L) and then subjected to a vacuum filtration by means of a filtration unit (Millipore, Brazil) that uses a membrane with a pore size 0.45  $\mu$ m (HV durapore, Millipore, Brasil).

This equipment is coupled to a vacuum pump (MZ2C, Merck, Chile). Filtered juice was stored in tubes with lids and placed in refrigerator at 4°C, protected from light. It must be mentioned that the pulp was removed by simulating what people do at home.

Identification and quantification of phenolic compounds by spectrophotometry

A scanning from 500 nm to 200 nm was performed (UV-VIS Jasco V-530 Spectrophotometer, Japan) in order to obtain the absorption maxima characteristics for flavonoids. Total phenol content was determined by means of the Folin-Ciocalteu method<sup>13</sup>. In order to achieve this, gallic acid was used as standard (Sigma-Aldrich, USA). With this, the calibration curve was prepared and the results were expressed as gallic acid equivalents (GAE). For determining total flavonoids, the method described by Jia et al. (1999)<sup>14</sup> was used. In order to achieve this, quercetin was used as standard (Merck, Germany). With this, the calibration curve was prepared and the results were expressed as quercetin equivalents (QE/mL).

Identification of phenolic compounds by HPLC

Phenolic compounds present in the *C. limon* juice were identified by means of high efficiency liquid chromatography (HPLC) in reverse phase, according to what described by Londoño-Londoño et al. (2012)<sup>15</sup>.

**Collecting clinical experiences:** An exploratory type study, descriptive and transversal was carried out during two and half months at the Dr. Víctor Manuel Fernández Family Health Center (CESFAM), locate in 2120 Maipú Street, Concepción city, Chile. In December 2011 the population of hypertensive patients regularly checked at the CESFAM reached 5051 people. A sample size of 10% of the total population of hypertensive patients regularly checked at the CESFAM was considered appropriate.

In order to perform a selection of patients, a sample by convenience was carried out, where all hypertensive patients who attend to medical checks or to withdraw their medications were included. However, patients had to meet the following criteria to be included: to be assigned to the Hypertension Program, and patients who had suffered a sudden blood pressure rise during the course of the disease. As exclusion, the following criteria had to be met: patients who keep blood pressure levels under control, and patients with communication problems that prevent the survey to be properly carried out.

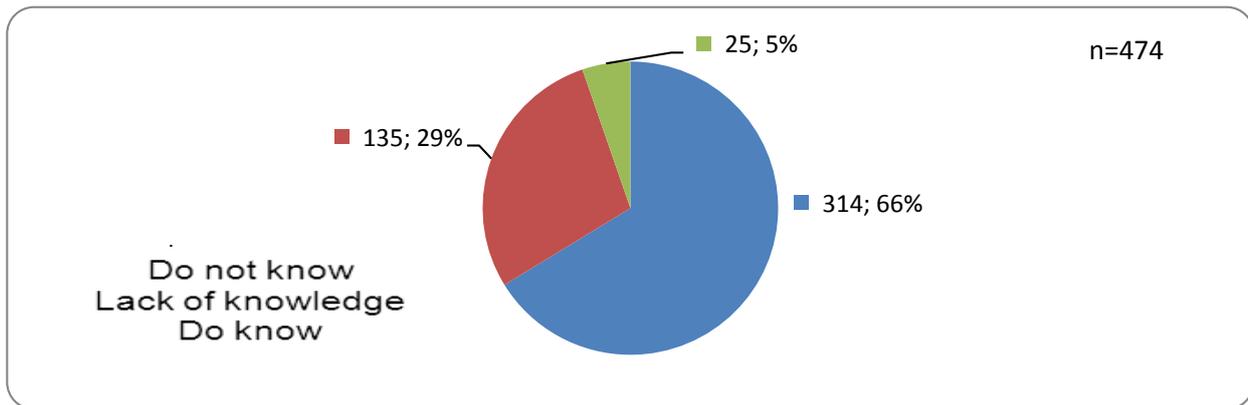


Fig. 2: Patient knowledge about hypertension

Information obtaining was carried out by means of the application of a survey to the hypertensive patients. This survey counted on the following variables: patient knowledge about their disease and drug therapy, knowledge about blood pressure sudden rises, the use of alternative/complementary medications and where that information was obtained. The survey was validated in nine hypertensive patients, prior to the application in the study population. Every patient had to sign an informed consent prior to the application of the survey. The information obtained from each patient by means of the survey was collected in a database. To each question the possible responses were codified with a number in order to facilitate its further analysis. In order to sort and analyze data, Microsoft Excel 2007 software was used.

**Pilot study:** A pilot study that counted on the participation of five hypertensive patients under medication treatment, who had a sphygmomanometer and who accepted to be subjected to this test at home, and seven non-hypertensive people. Each patient had to previously sign an informed consent and also complete a measurement table accompanying the protocol of the study. This table consisted on the following: hypertensive group – *to check blood pressure at rest and every day – if blood pressure values are equal or greater than 140/90 mmHg the patient must drink C. limon juice (a medium fruit) without water and check blood pressure at 10, 15, 20, 30 and 60 minutes*; control group: *to check blood pressure at rest all days during three consecutive days – and to drink C. limon juice (a medium fruit) without water and check blood pressure at 10, 15, 20, 30 and 60 minutes*.

## RESULTS AND DISCUSSION

**C. limon juice obtaining:** From a medium size lemon with a mass of 103.04 g, 30 mL of juice with typical organoleptic characteristics of *C. limon* were obtained.

**Identification and quantification of phenolic compounds by spectrophotometry:** Flavonoids are characterized by presenting an intense absorption in both visible and ultraviolet spectrum, due to the presence of conjugated aromatic rings. Absorption maxima characteristic for flavonoids were observed at 330 nm and 280 nm.

Total phenolic content for samples of filtered *C. limon* juice reached  $(329.09 \pm 0.01) \mu\text{g GAE/mL}$ .

**Identification of phenolic compounds by HPLC chromatography:** Chromatogram obtained by analyzing the *C. limon* juice filtered by HPLC is presented in Figure 1, respect to its flavonoids content.

Flavonoids that can be observed in the above figure are consistent with the chemical composition described in the literature for *D. limon*. The major compounds present in the *C. limon* juice are flavonones such as hesperidin and eriocitrin. On the other hand, the flavonone diosmin is present in small concentrations<sup>16</sup>.

**Collecting clinical experiences:** A total of 506 patients were interviewed. From these, 474 (93.7%) had suffered sudden blood pressure rises. These patients constituted the study sample.

69.6% were female and 30.4% male, whose age range was concentrated between 50 and 80 years.

From the analyzed population, only 14.1% mentioned not presenting any comorbidity associated to HTN, declaring it as their only disease. 37.3% of the population had Type 2 diabetes mellitus (DM-2). This disease is specifically mentioned because when performing the survey there were patients that indicated they were unable to determine whether symptoms of decompensation were due to a sudden rise in blood pressure, or an impaired glucose. 71.9% of the population also presented some comorbidity different from DM-2. Among the most mentioned, hypothyroidism, arthritis, glaucoma, osteoporosis, asthma and dyslipidemia can be mentioned.

Data found in relation to the knowledge the patients had regarding blood pressure are presented in Figure 2.

Only a low percentage of the interviewees have certain knowledge about hypertension. However, none of them mentioned the fact that this is a chronic disease. On the other hand, 53% of the interviewed population had no knowledge about their drug treatment, so many of them could not remember the name of any of their medications. Within the population, only 84.4% could remember a sudden blood pressure rise, mainly based on the presented symptoms. Most frequently mentioned symptoms were dizziness (47.9%), heat (46.4%) and headache (36.5%).

When facing these sudden blood pressure rises, the most mentioned actions were resting (55.4%) and drinking lemon juice or other home remedies (39%). With these measures, 70.7% noted a lowering in the blood pressure by decreasing or normalizing symptoms or because they just

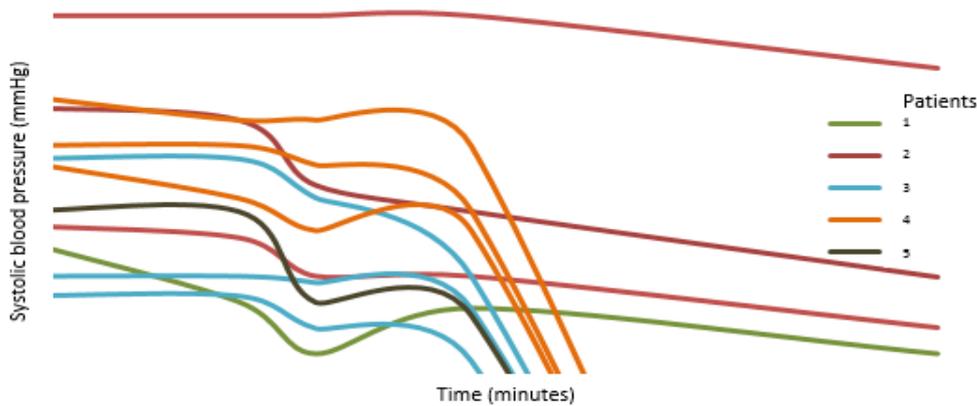


Fig. 3: Changes in systolic blood pressure in hypertensive people alter patients after drinking lemon juice against a sudden rise.

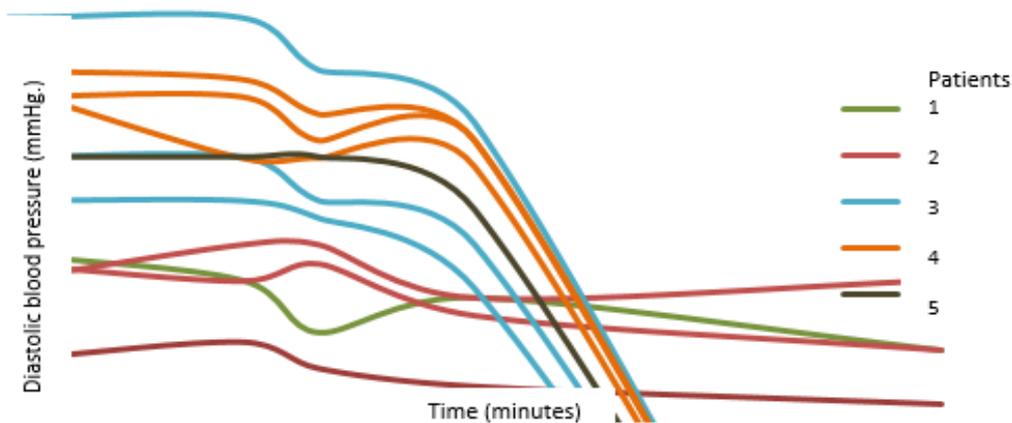


Fig.4: Changes in diastolic blood pressure in hypertensive people alter drinking *C. limon* juice against a sudden rise felt better.

61.9% of the respondents reported having taken a home remedy to lower their blood pressure. Lemon juice was the most important, appearing in 95.2% of the responses. Among other home remedies used, the most frequently mentioned were olive tree leaves (*Olea europea*), “bitter plants”, huayo (*Kageneckia oblonga*), natre (*Solanum crispum*) and cachanlagua (*Schubria pinnata*). These plants have a broadly described hypotensive effect<sup>17,18</sup>. In general, it was observed that most patients (46.8%) consume lemon juice diluted in water and report feeling better after 30 minutes.

Pilot study: In order to complement the gathered information, a pilot study with hypertensive and non hypertensive patients was carried out. The aim of this study was to clarify certain aspects in which the analyses the survey were not conclusive.

In the hypertensive patients group it was observed that although a slight decrease in the blood pressure occurred at approximately 15-20 minutes, this pressure was not maintained over time and after 60 minutes, this pressure had returned to values similar to the initial one. This may be due to the fact that by being patients without blood pressure problems, the organism is capable to quickly compensate this change and maintain normal values. This also coincides with the fact that normotensive people do

not suffer hypotensive episodes when dressing their salads or foods with lemon.

Changes in the systolic blood pressure for the group of hypertensive patients after drinking lemon juice are shown in Figure 3.

As shown in the figure 3, the decrease in the systolic blood pressure (SBP) started within 15.20 minutes. After 30 minutes an average decrease of 10 mmHg was observed. This decrease seems to be sustained and decreasingly lower as time progresses.

The largest decreases in the blood pressure values were registered between the values of 150-160 mmHg.

A curious case was presented by a patient who suffered a hypertensive crisis, with systolic blood pressure values of 180 mmHg. In this case, *C. limon* juice was unable to initiate a rapid blood pressure drop like in the exposed cases, being registered a lowering of 4 mmHg only at 45 minutes and a decrease of 8 mmHg after 60 minutes. Based on these outcomes, it would be very important to check the effect with higher pressure levels, especially taking into account that during a hypertensive crisis the values of the systolic blood pressures can exceed 200 mmHg. Due to this, it is not recommended to drink lemon juice because of its low and small variation of observed pressure. Although this was an isolated situation, it would be consistent who, when surveyed exposed that *C. limon* juice

was helpless when they presented a hypertensive crisis. In those cases, patients had to attend to an emergency service. Diastolic blood pressure measurements from hypertensive patients who participated in the study are shown in Figure 4.

This figure 4 indicates that a decrease in the diastolic blood pressure was initiated between 20 and 30 minutes after drinking the juice, with an average decrease of 6 mmHg at 30 minutes. Like systolic blood pressure, diastolic blood pressure seems to be sustained over time. The largest decreases were observed after 30 minutes, in patients who had a diastolic blood pressure lower than 80 mmHg and decreases between 5 and 12 mmHg were observed. On the other hand, in patients with diastolic blood pressure the decreases ranged between 6 and 6 mmHg. In the case of a patient who presented a hypertensive crisis the values of the diastolic blood pressure were quite variable over time and no sustained decrease was registered.

From the analyses of these data it can be noted that the decrease produced by the ingestion of *C. limon* juice tend to be directly proportional to how high the value is found. Of all patients, only two of them presented symptoms when their blood pressure was high. One of them felt nausea and dizziness in the three performed measurements and the other said feeling hot and having an eye stroke. These patients mentioned a decrease in their symptoms when the diastolic blood pressure had dropped an average of 11 mmHg and 7 mmHg in the case of the diastolic pressure. These patients were not measured after 60 minutes, so there are no data on whether the decrease in the blood pressure continued over time.

As additional data, a measurement of the blood pressure in a 38 year old patient diagnoses as hypertensive and who had stopped taking medication two months before the measurement. He mentioned feeling an occipital headache, so the blood pressure was measured, being found a value of 140/100 mmHg. Consequently, this person drunk *C. limon* juice and after 60, values of 133/90 mmHg were observed. Given this experience it would be assumed that *C. limon* juice would have an effect in lowering blood pressure in people who are not taking antihypertensive medication. Due to the fact that this is an isolated case, it can be considered as a possibility for future analysis.

All patients who participated in the study mentioned drinking *C. limon* juice against a blood pressure sudden rise. They also mentioned that the lemon helped them against this matter.

Sari et al. (2012)<sup>19</sup> carried out a study with 80 Turkish hypertensive patients in order to determine if *C. limon* juice had any influence on blood pressure. In this study it was concluded that *C. limon* juice with sugar significantly decreased both diastolic and systolic blood pressure. However, this was also observed in patients who only drunk water, without a significant difference between both groups. In the group of patients with blood pressure lower than 140/90 mmHg it was determined that neither *C. limon* juice with sugar nor water affected systolic or diastolic blood pressure. It must be taken into account that in this study the way in which the *C. limon* juice was obtained or whether or not if the pulp is used is not mentioned.

Moreover, no analysis on the compounds present in the used juice was carried out, so it is not possible to infer about its chemical composition.

Studies on quercetin and on other flavonoids describe that these compounds, in an isolated way decrease blood pressure in hypertensive patients, but not in normotensive or pre-hypertensive people. Reductions in blood pressure are in average as follows:  $-7 \pm 2$  mmHg for systolic and  $-5 \pm 2$  mmHg<sup>20-25</sup> for diastolic. This evidence accounts the hypertensive effect polyphenols produce by being consumed in the diet. Although the concentrations that this phytocomplex has are lower, it contains several compounds that would exert the hypertensive effect by means of a number of mechanisms<sup>22,26-28</sup>.

In the present study, a sustained decrease over time was observed in the patients who were suffering a blood pressure rise. These results are not conclusive due to the low number of hypertensive patients who participated and to the inexistence of a control group. As a result, it becomes necessary to develop more comprehensive studies that take into account the deficiencies mentioned for both studies.

When analyzing the obtained results and ignoring the mechanism by which the drop in the blood pressure is produced, it becomes necessary to educate the population about this popular issue. It was observed that *C. limon* juice helps to lower the blood pressure when this is elevated, turning out to be a useful self-care measure, because against sudden blood pressure rises there are no protocols that medical services or patients themselves can perform at home when this situation is faced. In addition, this is a quick and easy measure with a low cost for the patient. However, it is necessary to disclose to the public the limitations this popular use has and emphasize the importance of the regular medical control of the blood pressure and the proper adherence to the treatment. Regarding symptoms, it must be said that hypertension is a silent disease under which the absence of symptoms does not mean that the disease is controlled and of course, not cured.

In the performed study it was observed that *C. limon* juice is capable to lower blood pressure when this is elevated in hypertensive patients, without influencing on the blood pressure in normotensive patients. Hence, it can be concluded that *C. limon* juice would have hypertensive properties. These properties must be corroborated with further studies and in larger populations.

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