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Pulcandi a healing natural ash coal against gastric acidity: Scientific comprehension

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As a coal, Pulcandi possesses the property of removing excess gastric and intestinal gas. Pulcandi powder has anti-diarrhea activity by decreasing intestinal fluid content and adsorbing microbes and toxins. The aim of this study was to demonstrate and to establish consequences of Pulcandi powder use on gastric acidity. For evaluating these consequences, it was investigated *in vitro* kinetic tests on acidity. These tests were followed by acidic dosages performed on Pulcandi aqueous extractions solutions. In this way, preparations were composed of 2.5 g powder mixed with 100 mL HCl acidic solutions. The study results revealed evident decrease of acidity with Pulcandi. However, the local concentration of protons impacted on this variation, which led to conclude that this coal do not increase pH when ulcers troubles don't occur. Infra-Red analyses (IR-ATR) were also performed on Pulcandi powder. The results evidenced presence of nitrate and bicarbonate ions neutralized protons. Moreover, essential minerals (Ca, Na, K, and Mg) present in Pulcandi powder could improve the coal properties and efficacity.

Key words: Pulcandi, coal, extraction, acidity adsorption.

INTRODUCTION

Gastric mucus is a whole of mucosa substances produced by cardial, pyloric and fundic cells. Mucus forms a double barrier of protection. This barrier prevents direct contact between stomach cells and gastric juice (HCl and pepsin). In fact, the pH at the surface of this barrier is 1.5 whereas it is 7 in deep zone. Cells producing gastric mucus, also produce important quantity of bicarbonate ions (HCO_3^-) which neutralize locally protons ions. Then they have a chemical protective role (Murray et al., 2000).

Gastro-oesophageal reflux disease (GERD) is a common disease in Western countries and the number of patients with GERD is increasing in Japan as well (Shinkai et al., 2014). Gastric ulcer is common gastrointestinal tracts disorder that affect about 10% of the world population. It is characterized by gastrointestinal tract bleeding, perforation and erosion of the mucosa wall due to imbalance between aggressive and defensive factors. Aggressive factors are acid, pepsin and *Helicobacter pylori* (Adefisayo et al., 2017).

Gastric acid is known to cause marginal ulcers, situated in the small bowel just distal to the upper anastomosis

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(Bekhali et al., 2017). Defensive factors are: mucin, prostaglandin, bicarbonate, nitric oxide, mucosal blood flow and growth factors (Adefisayo et al., 2017). Proton pump inhibitors (PPIs) are known to be the most effective drugs that are currently available for suppressing gastric acid secretion. However, other studies have reported that PPIs may not be able to render stomach achlorhydric, and have identified a phenomenon of increasing gastric acidity at night in individuals receiving a PPI twice daily (Shim et al., 2017).

Secular, ancestral and traditional knowledge reported in literature demonstrated that coal suppresses excess gastric and intestinal gas, neutralizes microbes and toxins. It heals diarrhea and gastroenteritis. Coal is a black color solid combustible matter with plant origin containing high proportion of carbon. It is a fine, odorless and smooth powder. Active or activated coal obtained by pyrolysis has a porous structure. Depend on the transformation temperature, the obtained product conserves initial properties or acquires new properties (Avom et al., 2001).

Among the different methods to prevent intestinal absorption of ingested poisons, charcoal is the easiest to administer, has few side effects and is preferred by most volunteers (Daniel et al., 1988). Activated charcoal is a method of gastric decontamination that is now being recommended for patients who have ingested potentially toxic amounts of poison up to 1 h previously (Christophersen et al., 2002). Activated charcoal has the ability to adsorb a wide variety of substances. This property can be applied to prevent the gastrointestinal absorption of various drugs and toxins, and to increase their elimination, even after systemic absorption (Neuvonen et al., 1988).

Clinical studies in 2002 recommended gastric lavage or gastric lavage followed by activated charcoal which may be replaced by charcoal alone for treating (Christophersen et al., 2002). Activated charcoal (AC) is a non-selective and highly effective adsorbent (Jia et al., 2013). For example, significant *in vitro* binding of colchicine to AC suggests that AC has a role in decontamination of patients after ingestion of *Gloriosa superb* (Zawahir et al., 2017).

Gastric acidity is different in various disease states and its measurement may be useful in the diagnosis and treatment of these diseases. Gastric acid measurement may also be useful in assessing the effectiveness of new antisecretory drugs (Sinkai et al., 2014). Pulcandi is a black, fine, odorless and smooth powder obtained by fodder crops calcinations. This later contains mineral such as potassium, magnesium or sodium. It is not well known how Pulcandi powder interacts with gastric biomolecules to heal ulcers and gastro-enteritis. A special interest has been shown by scientists regarding the popular testimonials on the product.

The aim and motivation of this study was to establish scientific comprehension of the efficiency of this product, and to show its bioactivity.

MATERIALS AND METHODS

Chemicals

The product Pulcandi was produced by Centre Omnitherapeutique Africain (COA). (African Omnitherapeutical Center). Chlorhydric and sulfuric acids were purchased from Prolabo (Togo) and phenolphthalein from Sigma (France). Distilled water was obtained from laboratory of Biochemistry Department (Universite de Lome). Experimentations were performed in the biochemistry laboratory of COA. Infra-Red analyses were performed in CRISMAT Laboratory (France).

In vitro kinetic tests on acidity

50 mL of an aqueous Pulcandi solution with a concentration corresponding to adult posology, meaning 10% in water, was added to 150 mL of an acetic acidic solution (pH=1) mimicking gastric acidity. The mixture was shaken for 100 min with a Titramax 100T orbital shaker at 600 rpm. The pH values were then measured each 5 min with a pH-meter. Each experiment was done in duplicate, and the mean value was recorded.

Aqueous extractions and acidic dosages

To a 0.1M HCl solution, 2.5 g /100 mL Pulcandi powder was added. The mixture was shaked for 1 h with a Titramax 100T orbital shaker (600 rpm) at 25°C. This solution was filtered with a Whatman filter paper and 25 mL was dosed. To the filtered solution 2.5 g /100 mL Pulcandi powder was once again added. The obtained solution was shook for 1 h with a Titramax 100T orbital shaker at 600 rpm at 25°C, filtered with a Whatman filter paper and 25 mL was dosed. The same process was done a third time. To perfome each step dosage, 1 mL of phenolphtalein (1% in acetone) was added and the titration was done with a 0.1 M NaOH solution. The mixture was gently stirred with an Ikamag magnetic stirrer until neutralization occurred. Each experiment was done in duplicate and the mean value was recorded (Table 1).

Infra-red analysis

Infra-red spectra of Pulcandi powder was registered from 2000 to 600 cm^{-1} on a spectrophotometer IR Tensor 27 with an ATR reflexion module.

Minerals composition and concentration

Minerals elements concentration (Ca, K, Mg, Na) were determined by absorption of spectrophotometry. For this, Pulcandi powder was mineralised by 1.5mL nitric acid. The mixture was then heat until a viscous liquid was obtained, and then distilled water was added. The solution is filtered and diluted. Mineral element concentration determination was done with an atomic absorption spectro-photometer AA Solar, Tehrmo Electron Corporation (Germany).

RESULTS

In vitro Pulcandi kinetic tests on acidity

Figure 1 shows an increase in pH from 0.99 to 1.28 pH

Table 1. Extractions and dosages processes.

Steps	Mixing	Filtrate	Dosage
1: Initial solution V = 300 mL [HCl] = 0.1 M	V = 300 mL mPulc = 7.5 g Concentration : 2.5g /100mL Shaking : for 1H at 600 rpm Temperature: 25-30°C	No. 1	N°1 Duplicate V = 25 mL V_{NaOH} = 13.725 mL
2: Filtrate N°1 V = 200 mL	V = 200 mL mPulc = 5 g Concentration : 2.5g /100mL Shaking : for 1H at 600 rpm Temperature: 25-30°C	No. 2	N°2 Duplicate V = 25 mL V_{NaOH} = 9.45 mL
3: Filtrate N°2 V = 100 mL	V = 100 mL mPulc = 2.5 g Concentration : 2.5g /100mL Shaking : for 1H at 600 rpm Temperature: 25-30°C	No. 3	N°3 Duplicate V = 25 mL V_{NaOH} = 5.1 mL

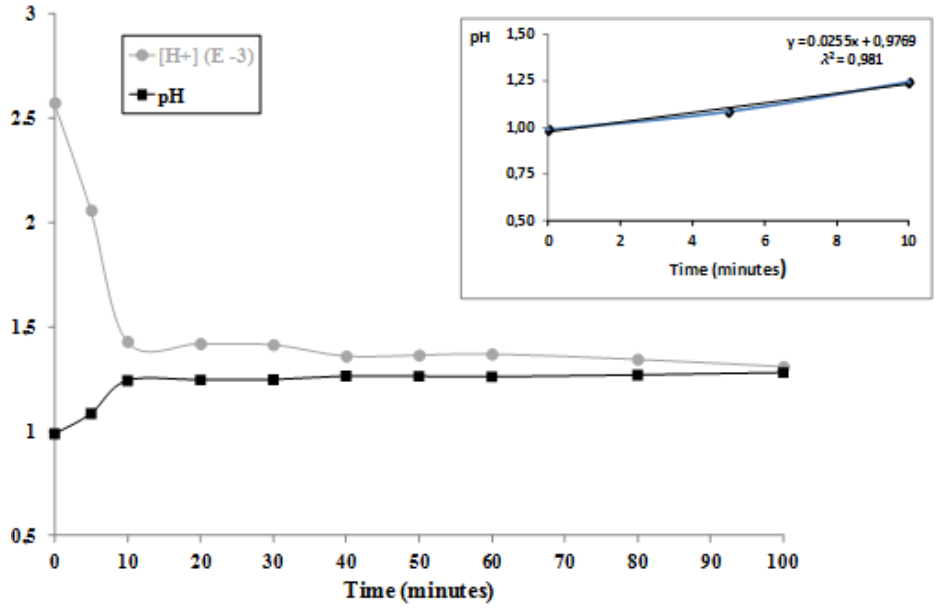

Figure 1. pH (■) and concentration of proton ions (●) evolutions of an acidic solution added with Pulcandi.

units at a kinetic of $25.5x10^{-3}$ unit.min^{-1} within the earlier 10 min. Afterwards, no more variation was observed. The trend went upward from 0 to 10 min with R^2 = 0.981 which indicates an initial rate ($25.5.10^{-3}$ unit.min^{-1}) followed with stagnation. This increase in pH values reflected in contrast a fast decrease (50%) of acidity from $2.6.10^{-3}$ M of protons to $1.3.10^{-3}$ M of protons in the presence of Pulcandi powder. This phenomenon was observed also within the earlier 10 min. This variation of 0.29 units of pH corresponded to a difference of $5.06x10^{-2}$ M of protons. This result was confirmed by a continuous dosage of a 0.1 M HCl solution (data not shown).

Preparation of aqueous extractions and acidic measurements

The primary processing of the sample was carried out according to the steps shown in Table 1. The working concentration of 2.5 g / 100 mL was used along the three

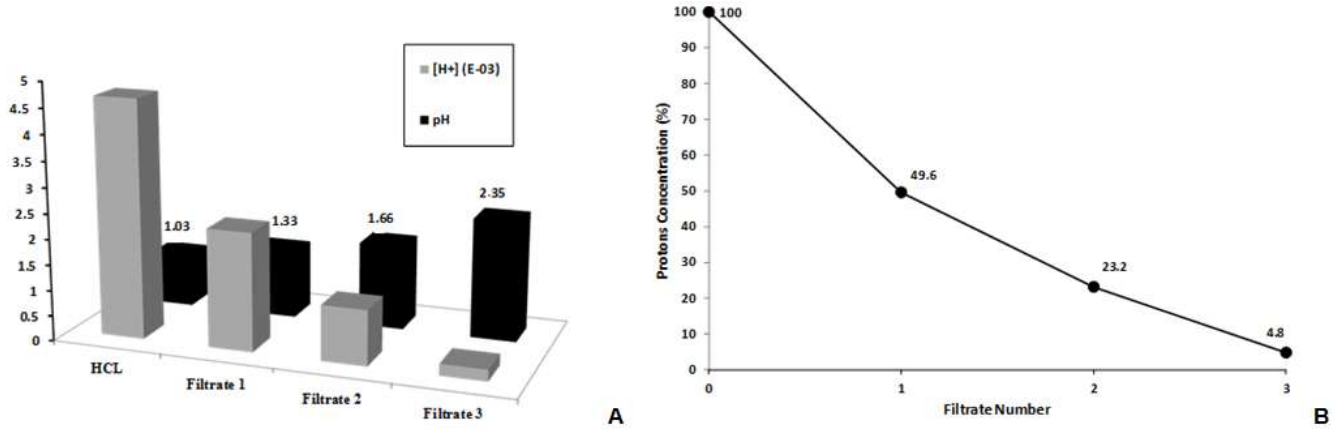

Figure 2. (A) Dosages of an acidic solution added with three fold Pulcandi (Protons concentrations and pH values); (B) Dosages of an acidic solution added with three fold Pulcandi (Variations of protons concentrations vs filtrate number).

Table 2. Relation between Pulcandi powder mass and quantity of protons adsorbed.

Filtration	Quantity of protons for 2.5 g of Pulcandi powder	Quantity of protons per g of Pulcandi powder (mol/g)
Filtrate 1	2.35	0.94
Filtrate 2	1.23	0.49
Filtrate 3	0.85	0.34

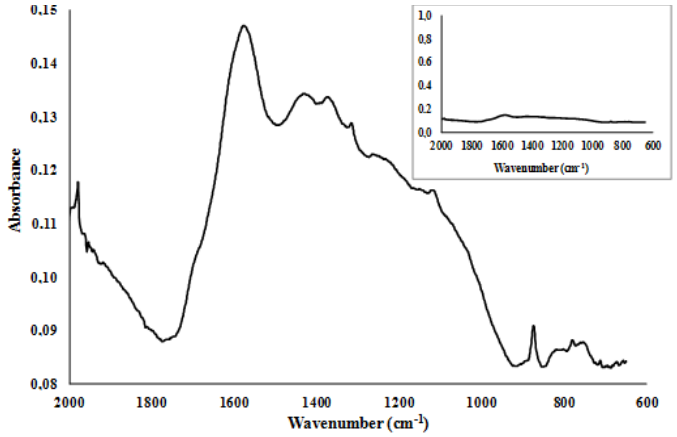

Figure 3. IR-ATR spectrum of Pulcandi powder.

times extraction. Results of these aqueous extractions acidic dosages (Figure 2A) highlight a progressive decrease of protons when filtration was on. In the same time, pH values evolve conversely and were doubled. Figure 2B highlights the fact that with the first dose of Pulcandi powder (2.5 g), 51.4% of protons were already adsorbed. The second dose of the same mass (2.5 g) adsorbed this time 26.4% of protons ions. Finally, the third dose had led to 18.4% adsorption. The variations were similar for a second sample (data not shown). To elucidate this phenomenon, we searched to determine the molar quantity of protons adsorbed by gram of Pulcandi powder at each step of filtration. Results are presented in Table 2. The quantity of acidic ions per gram of Pulcandi powder varied from 0.94 mol/g to 0.49 mol/g and from 0.49 mol/g to 0.34 mol/g. Infra-Red spectra of Pulcandi powder were very difficult to obtain (Figure 3). We tried many times without any result (Transmittance = 100%). We decided then to reduce the scale end enlarge the spectra measuring in absorbance. NO_2 group was determined at 1575 cm^{-1} which was confirmed at 1374 cm^{-1}. At 1431 cm^{-1}, the corresponding group was OH in carboxylic acids. Other signals were too weak to analyse.

Mineral components of Pulcandi

As Pulcandi powder is an ash coal, we investigated the presence of essential minerals. Mineralisation analyses revealed the presence of Calcium, Natrium, Potassium and Magnesium respectively at 1445, 60, 2150 and 251 mg% (Table 3).

DISCUSSION

Different analyses were done successively to achieve and understand the mechanism of action of Pulcandi powder: aqueous extractions, acidic dosages, Infra-Red

Table 3. Essential minerals present in Pulcandi powder.

Essential minerals	Pulcandi contents (mg%)
Calcium (Ca)	1445
Natrium (Na)	60
Potassium (K)	2150
Magnesium (Mg)	251

analyses and mineralisations.

The pH increasing of acidic solutions added with Pulcandi powder during the earlier 10 min (Figure 1) at a rate of $25.5x10^{-3}$ unit/min, allowed to confirm patients' observations on Pulcandi powder. In fact, patients´ observations led to beneficial effect after 20 min including a light feeling of heartburn during the first 10 min.

It is necessary to take into account *in vivo* conditions when applying *in vitro* digestion methods, in order to maximally reproduce them. The gastric phase is performed with HCl or HCl-pepsin under fixed pH and temperature conditions, for a set period of time (Alegria et al., 2015). This was the reason this study was conducted with HCl acidic solutions at 0.1 M. The three steps corresponded to Pulcandi posology, that is, one teaspoon (2.5 g) with water (100 mL) 3 times a daily.

From the study observations, results presented in Figure 2A and B demonstrated drastic diminution of protons concentration from 100 to 4.8%. These variations are correlated with 51.4% protons adsorption, 26.4% of protons adsorption and finally 18.4% adsorption respectively after the first, the second and the third dose taken. The variations were similar for a second sample (data not shown).

Biochemical explanations are, on the one hand, parietal cells of the gastric mucosa secrete chlorhydric acide (HCl) which was neutralized by the mucus composed of bicarbonate ions (HCO_3^-) (Murray et al., 2000). When *H. Pylori* infection occurs, the mucous cells are deteriorated preventing the regulation of HCl secretion. The mucous is then damaged leading to ulcers. In another hand, we also know that plant ashes are essentially composed of bicarbonate ions (HCO_3^-) which are easily dissolved in water (Javillier, 1959). More, active coal was used in medicine as chelating product in many cases of intoxications. Then acidity adsorption property of Pulcandi powder ancestrally known and confirmed by the study results, is due to similar role of Pulcandi powder as mucus. The role of Pulcandi powder is to achieve quickly sufficient adsorption of protons.

To confirm the identity of the component that could neutralize protons, infra-red analyses were done on Pulcandi powder. Spectrum in Figure 3 (The profile of a second sample was the same. Data not shown) shows the presence of NO_2 group in aliphatic nitro compounds and OH in carboxylic acids which could come from carbonic acid. These results show that this coal possesses without doubt nitrite (NO^{2-}) and / or nitrate (NO^{3-}) ions as well as bicarbonate ions (HCO^{3-}). We then strongly suppose that nitrite (NO2-) and nitrate (NO^{3-}) ions frequently present in plants ashes came from atmospheric nitrogen (N). They could also have been produced during the transformation of Pulcandi powder since coal combustion produces nitric oxide (Lehninger, 1982).

Indeed, ashes represent comparatively to the real chemical composition of living, something artificial. It can be easily imagined that, in a certain tissue, salts provided from organic acids saturation by minerals basis; the organic part of such molecules will undergo the combustion and bases will subsist, generally in carbonate forms (Javillier, 1959). Then, these ions present in Pulcandi powder will neutralize protons in acidic solutions. They play defensive roles (Adefisayo et al., 2017).

Table 2 shows Pulcandi powder contents essential minerals: calcium, natrium, potassium and magnesium. In 2013, a team of scientists demonstrated that the phosphate-binding ability of calcium chloride was improved by AC in intestinal fluid (Jia et al., 2013). Potassium ions are implicated in proton pomp mechanism (Murray et al., 2000) and their concentration (2150 mg%) is the double of the concentration presents in lentils (1200 mg%), a high potassium content food. This study was deepened by determining the quantity of protons adsorbed per gram of Pulcandi powder at each step of the process. The values obtained and presented in Table 2 allowed to estimate the efficiency of Pulcandi powder. We remarked that less and less protons were adsorbed as filtrations go by. This highlights that the more higher the local protons concentration was, the more these ions are adsorbed in Pulcandi powder.

In contrast, in a low protons concentration environment, protons did not "knock" themselves to enter the pores of the calcinated powder. A maximum efficiency of adsorption was obtained after the first filtration (approximately 51.4%). The adsorption phenomenon observed here is first of all the probability of access to the charcoal pores after three doses. However, repeated doses of charcoal also reduce the risk of desorption from the charcoal-toxin complex as the complex passes through the gastrointestinal tract (Neuvonen et al., 1988). Then, it is not a question of saturation of Pulcandi powder in our study as Figure 1 could suggest, meaning a given mass could not adsorb more than a determined quantity of protons. It is a question of protons capacity to hit powder particles or eventually being in competition with water molecules (H2O). Gastric acid suppression was reported to increase the risk for development of drug hypersensitivity reactions.These consequences of anti-ulcer drug intake associated with direct influence of these drugs on immune responses. On the other hand reduction of gastric acidity leads to impaired gastrointestinal protein degradation (Untersmayr, 2015).

Using Pulcandi, a biocompatible natural ash coal prevents those chemical drugs consequences. This powder is then of practical interest.

Conclusion

The main point of this study was the evident diminution of acidity when Pulcandi powder was added. However, acidity adsorption was not systematic and drastic. As it depends on local concentration of protons, anyone who takes Pulcandi powder without suffering of gastric acidity ulcers will not be subject to a sudden gastric juice alkalinisation. This last phenomenon will allow a bacterial proliferation leading to other troubles. Such biochemical analysis lead to Pulcandi powder generated promising preclinical and clinical results for treatments of gastric ulcers with Pulcandi powder. The study results have shown that Pulcandi is highly active in protons suppression. It would be interesting to continue our experimentations focus on magnesium and potassium which are important ions implicated in psychosomatic gastric ulcers.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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