ANTI-DIARRHOEAL ACTIVITIES OF AQUEOUS STEM BARK EXTRACT OF AMBLYGONOCARPUS ANDONGENSIS (WELW.EX OLIV.) EXELL & TORRE

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ABSTRACT

Amblygonocarpus andongensis (Welw.ex Oliv.) Exell & Torre is used extensively in Sokoto state, Nigeria for the treatment of diarrhoea, pain and psychosis. The aim of this study was to evaluate the anti-diarrhoeal properties of aqueous extract of stem bark of Amblygonocarpus andongensis in Wistar rats. The aqueous extract (200, 400 and 600 mg/kg, p.o. in rats) was evaluated for anti-diarrhoeal properties against castor oil-induced, gastrointestinal motility and prostaglandin E$_2$ (PE$_2$)-induced enteropooling models of anti-diarrhoeal studies in Wistar rats. Isolated Guinea-pig ileum was used to evaluate the antispasmodic effect of the plant extract. The parameters observed were the total number of diarrhoea faeces and the onset of the production of the faeces in the castor oil-induced model; the distance travelled by charcoal meal in the gastrointestinal motility test; the volume of intestinal content in PE$_2$-induced enteropooling assay; and the length of contraction exerted on the isolated guinea-pig ileum in the antispasmodic experiment. The extract significantly (p<0.001) reduced faecal output and delayed the onset of defecation against the castor oil-induced diarrhoea. It also significantly (p<0.001) inhibited the propulsion of charcoal meal in the gastrointestinal motility test. Similarly, the extract at all dose levels significantly reduced the volume of intestinal content against PE$_2$-induced enteropooling assay. The extract (1, 2, 4, 8 and 16 mg/ml) also exerted a significant (p<0.001) inhibitory response on acetylcholine-induced smooth muscle contraction in the isolated Guinea-pig ileum. It demonstrated anti-diarrhoeal properties which may be due to its anti-motility/antispasmodic and anti-secretory effects. These therefore lend pharmacological credence to its folkloric use in the treatment of diarrhoea.

Key words: Amblygonocarpus andongensis; acute toxicity; Anti-diarrhoeal activity; guinea-pig ileum; Enteropooling; Castor-oil

INTRODUCTION

Diarrhoea is one of the most common gastrointestinal disorders, characterized by an increase in frequency and production of watery stool (Farthings, 2002). In most developing countries like Nigeria, it constitutes a major health challenge with high prevalence in children and infants (Audu et al., 2000). Amongst the developed countries, it is still a significant health issue regardless of their more stable
public health and economic wealth (Casburn-Jones and Farthing, 2004). According to the world health organisation (WHO) report, it is estimated that diarrhoea causes 4–5 million deaths annually throughout the world. Eighty percent of these deaths are reported in developing countries including Nigeria (Yilgwan and Okolo, 2012). Various types of drugs are available for the treatment of diarrhoea. Such drugs are anti-motility agents (atropine, loperamide hydrochloride, and codeine), adsorbents (activated charcoal, kaolin, and cholestyramine), antibiotics and many others. These drugs even though they are effective for the management of this disorder, they suffer from many side effects such as headache, dry mouth, rashes, fever, and severe allergic reactions (Sharma and Sharma, 2007). Hence, there is always a continuous need to search for a safer alternative to these available drugs.

In developing countries, majority of the people depend on traditional medicine in treating all kinds of diseases including diarrhoea (Lin et al., 2002). The WHO has encouraged scientific studies for the treatment and prevention of diarrhoeal disease based on traditional practice because of fewer side effects associated with it. Many studies have justified the traditional use of anti-diarrhoeal medicinal plants by evaluating the biologic activity of extract of such plants which have antispasmodic effects, suppress gastrointestinal motility, stimulate water adsorption or reduce electrolyte secretion (Palombo, 2006). Among the medicinal plants with therapeutic potentials, the genus ‘Amblygonocarpus’ is of great importance. *Amblygonocarpus* is a genus of flowering plants in the legume family, Fabaceae belonging to sub family Mimosoideae. It is a genus of one species in tropical Africa and contains plants species names as *obtusangulus* Harms (*Tetrapleura obtusangula*), *schweinfurthii* Harms and *andongensis* (Welw.ex Oliv.) Exell & Torre. All these are synonyms of the accepted plant name *Amblygonocarpus andongensis* (Welw.ex Oliv.) Exell & Torre.

*Amblygonocarpus andongensis* is a deciduous tree commonly distributed throughout tropical Africa (Burkill, 1985). It is usually 30–40 feet high, but reaching 60 feet and 5 feet girth in moist areas. It is commonly known as Scotsman’s rattle, ‘Kolo’ in Hausa and ‘jigaree-hi’in Fulfulde languages of Nigeria. The root decoction is usually administered as an emetic to treat food poisoning. It is also used against colic and cough and as a vermifuge. The decoction of the stem bark is used as an antidiote for snakebites and can be applied to sores. The stem bark can also be macerated and used to treat diarrhoea (Burkill, 1995) and breast cancer (Kubmarawa et al., 2007). The leaf extract is used to treat stomach-ache and the powdered pods to treat ulcers.

The plant has been previously evaluated for its use in the treatment of pain (Nwiyi, et al., 2006) and psychosis (Ebboh, et al., 2010). In Sokoto, the use of this plant for the treatment of diarrhoea has continued without scientific evidence. Therefore, the aim of this study is to evaluate the anti-diarrhoeal activity of aqueous stem bark extract of *Amblygonocarpus andongensis* using castor oil-induced diarrhoeal model, gastrointestinal (GI) motility test, Prostaglandin E<sub>2</sub> (PGE<sub>2</sub>)-induced enteropooling assay in Wistar rats and antispasmodic studies using isolated guinea-pig ileum.

2. MATERIALS AND METHODS

2.1. Drugs and chemicals
Castor oil (Bell Sons and Co., England), Charcoal meal (10% activated charcoal in 100 ml of 5% aqueous gum acacia), Acetylcholine and Atropine Sulphate (Sigma Chemicals, USA), Loperamide (Janssen, England).
2.2. Plant material
The plant material (stem barks of *A. andongensis*) was obtained from Kara Market area in Sokoto North Local government Area of Sokoto State, Nigeria in the month of August and was identified by Dr. Halilu E. Mshelia, a taxonomist in the Department of Pharmacognosy and Ethnopharmacy, Usmanu Danfodiyo University, Sokoto. The plant material was stored in the herbarium of the same department with a voucher number Pcg/UDUS/Mimo/006.

2.3. Preparation of plant material
The stem bark of *A. andongensis* was washed with tap water, cut into smaller sizes and air dried under the shade to a constant weight. The dried stem barks were pulverised mechanically into a dry powder using a grinding machine. 300 g of the powdered plant material was macerated in 4.5 litres of distilled water for 24 hours with constant stirring. The resulting aqueous crude extract was evaporated to dryness using a hot air oven at 45 ± 1°C. A brownish powdery extract of percentage yield of 9.4% was realised. It was this extract that was dissolved in distilled and administered orally to the rats according to the required dose.

2.4. Animals
Wistar rats (*Rattus norvergicus*) of either sex (180-200 g) were obtained from Mike Ugwah animal house in the Usmanu Danfodiyo University Teaching Hospital, Sokoto. Guinea pigs (500-600 g) were acquired from the animal facility centre of the University of Nigeria, Nsukka. The animals were housed in standard cages and were allowed for 1 week for acclimatisation to our laboratory condition before the commencement of the study. Standard commercial chow and water were provided *ad libitum*. Housing conditions were maintained at 25 ± 2°C at 12 h day/night cycles. The study was approved by the Animal Research Ethics Committee of the Usmanu Danfodiyo University, Sokoto. The care and handling of the animals were in accordance with the Animal Research Regulation 1985-2010 and the Organisation of Economic Development (OECD) guidelines on good laboratory practice (OECD, 2008).

2.5. Phytochemical studies
The phytochemical evaluation of aqueous extract of stem bark of *A. andongensis* was carried out using the methods described by Trease and Evans (1983) and as modified by El-Olemmy *et al.* (1994) and Harbone (1993). The presence of alkaloids, glycosides, tannins, saponins, terpenoids, flavonoids, saponins glycosides, cardiac glycosides, anthraquinones, volatile oil, and steroids were tested.

2.6. Oral acute toxicity study
The oral acute toxicity study was tested using ‘Up-and- Down’ method at a limit dose of 3000 mg/kg in healthy adult female rats according to ‘OECD’ guideline no. 425 (OECD, 2001). Five female rats were randomly selected through a computer generated random numbers and labelled with picric acid for identification. An animal was picked at a time, weighed and dosed orally with 3000 mg/kg body of the extract after 18 h fasting. Each animal was observed after dosing for the first 5 minutes for signs of regurgitation and kept in a metallic cage. Then, they were observed every 15 minutes in the first 4 h, every 30 minutes for 6 h and daily for 48 hours for short-term outcome according to the specifications of OECD. The animals were monitored for a total of 14 days for long-term possible lethal outcome.

2.7. Anti-diarrhoal evaluation
2.7.1. Castor oil-induced diarrhoea in rats
The Castor oil-induced diarrhoea was conducted according to the method of Havagiray *et al.* (2004). Twenty five wistar rats were fasted for 18 h and divided into five groups of 5 animals per group. Groups 1-3 represented the plant extract...
groups (200, 400 and 600 mg/kg p.o), group 4 represented the reference drug group (loperamide 2.5 mg/kg, p.o.) while group 5 represented the vehicle control group (normal saline 1 ml/kg, p.o.). Food was withdrawn throughout the period of study but water was provided ad libitum. After 1 h of drug pre-treatment, each animal was fed orally with 1 ml of castor oil. The animals were kept in separate metabolic cages with a plain sheet of paper placed on the floor to collect their droppings. They were observed every hour for 4 h after castor oil administration. The onset of the production of the faeces and the total number of diarrhoea faeces were noted. The results were expressed as a percentage of diarrhoea inhibition.

\[
\text{Percentage of diarrhoea inhibition} = \left( \frac{T_0 - T_1}{T_0} \right) \times 100
\]

\(T_0\) = number of wet faeces in vehicle control group
\(T_1\) = number of wet faeces in test group

2.7.2. Gastrointestinal motility tests
Rats fasted for 18 h were divided into five groups of 5 animals each. Groups 1-3 represented the plant extract groups (200, 400 and 600 mg/kg p.o), group 4 represented the reference drug group that received atropine sulphate (0.1 mg/kg i.p. per rat) and group 5 represented the vehicle control group that received aqueous suspensions of acacia (1 ml p.o. per rat). Thirty minutes after the pre-treatment, 1 ml of charcoal meal (10% charcoal suspension in 5% gum acacia) was administered orally to each rat. The rats were sacrificed 1 h later and the intestine was removed from pyloric sphincter to caecum. The distance travelled by charcoal meal from the pylorus was measured and expressed as percentage of the total length of the intestine (Mascolo et al., 1994).

2.7.3. PGE\(_2\) induced enteropooling test
The method of Robert et al. (1976) was adopted. Rats fasted for 18 h were divided into five groups of 5 rats per group. Groups 1-3 represented the plant extract groups (200, 400 and 600 mg/kg p.o), group 4 represented the reference drug group (loperamide 2.5 mg/kg, p.o.) while group 5 represented the vehicle control group (normal saline 1 ml/kg, p.o.). After 1 h, 100 µg/kg of PGE\(_2\) was administrated orally to all rats to induce enteropooling. Thirty minutes after the administration of the PGE\(_2\), all rats were sacrificed and the whole lengths of intestines from pylorus to the caecum were dissected. The contents of the intestines were collected and the total volume measured.

2.8. Isolated guinea-pig ileum experiment
The guinea pig was fasted for 18 h before the experiment. After the animal was sacrificed, the midline incision of the abdomen was made and the ileum was isolated. The ileum was cut into strips of 2 cm long. A piece of ileum was mounted in a bath of 20 ml Tyrode’s solution (NaCl = 8.0, KCl = 0.2, MgCl\(_2\) = 0.1, CaCl\(_2\) = 0.2, NaH\(_2\)PO\(_4\) = 0.05, NaHCO\(_3\) = 1.0, and glucose = 1 g/L) with a controlled temperature of 37°C and aerated with 95% O\(_2\) and 5% CO\(_2\). Isometric concentrations were recorded under a resting tension of 1 g via a force displacement transducer and displayed on a polygraph (Ugo basile). After an equilibration period of 30 min, standard contractions produced by acetylcholine (ACh) (2, 4, 8, and 16ug/mL) were recorded. The tissue was then washed out with Tyrode’s solution. To test the inhibitory effect, the extract (1, 2, 4, 8 or 16 mg/ml) was added into the organ-bath 3 minutes before the addition of 8 ug/ml of ACh (which gave 16 mm response and taken as 100% response). The responses were noted. The same procedure was repeated using atropine sulphate (1, 2, 4, 8 or 16 µg/mL). The tissue was further washed 3-4 times after measuring the contractions at each dose of test substances.
The percentage responses were calculated (Department of Pharmacology, University of Edinburg, 1970).

2.9. **Statistical Analysis**

The data were analysed using Graph Pad Prism version 6 software. The results of the study are expressed as the mean (%) ± S. E. M. Comparison in all the groups was made using one-way analysis of variance (ANOVA) followed by Student’s t-tests. Differences were considered to be significant at \( p < 0.05 \).

3. **RESULTS**

3.1. **Phytochemical analysis**

Phytochemical analysis of the aqueous stem bark extract of *A. andongensis* revealed the presence of tannins, saponins, flavonoids, steroids, alkaloids, glycosides, terpenes, cardiac glycosides and saponins glycosides.

3.2. **Acute toxicity study**

There was no regurgitation or any obvious behavioural sign of toxicity in the animals according to the specification of OECD. There was also no mortality recorded at oral limit dose of 3000 mg/kg body weight.

3.3. **Anti-diarrhoea evaluation**

3.3.1. **Effect of aqueous extract of stem bark of Amblygonocarpus andongensis on castor oil-induced diarrhoea in rats**

In the castor oil-induced diarrhoea experiment, the extract treated rats produced dose-related, significant reduction in the production of diarrhoea faeces. The loperamide group was similar to 600 mg/kg extract group. Treatment with *A. andongensis* increased the percentage inhibition of diarrhoea and delayed the onset of defecation compared with the vehicle control group (Table 1).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Onset of faeces (min)</th>
<th>Mean number of diarrhoea faeces</th>
<th>% of diarrhoea inhibition</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 mg/kg Aa</td>
<td>105±9.55***</td>
<td>5.87±1.72*</td>
<td>42.62</td>
</tr>
<tr>
<td>400 mg/kg Aa</td>
<td>150±7.13**</td>
<td>3.48±0.31**</td>
<td>65.98</td>
</tr>
<tr>
<td>600 mg/kg Aa</td>
<td>210±7.33**</td>
<td>0.93±1.34***</td>
<td>90.91</td>
</tr>
<tr>
<td>Loperamide</td>
<td>215±9.89</td>
<td>0.45±1.02***</td>
<td>95.6</td>
</tr>
<tr>
<td>Control (vehicle)</td>
<td>27±6.67</td>
<td>10.23±1.22</td>
<td>0</td>
</tr>
</tbody>
</table>

Data presented as mean%± SEM, \( n=5 \) for all groups. *\( p<0.05 \), **\( p<0.01 \), ***\( p<0.001 \) compared with vehicle (normal saline) control group. Aa= *Amblygonocarpus andongensis*

3.3.2. **Effect of aqueous extract of stem bark of Amblygonocarpus andongensis on gastrointestinal motility test in rats**

Administration of aqueous extract of stem bark of *A. andongensis* significantly \( (p<0.001) \) slowed down the propulsion of the charcoal meal towards the caecum at all dose levels. At 400 mg/kg of the extract, the inhibition of the charcoal movement was comparable to that produced by atropine (0.1 mg/kg) the reference drug while at 600 mg/kg of the extract the inhibition produced was greater than the positive control (Figure 1).
3.3.3. Effect of aqueous extract of stem bark of Amblygonocarpus andongensis on PGE\(_2\)-induced enteropooling assay in rats

The administration of PGE\(_2\) resulted in intestinal fluid accumulation in the rats. The extract at all dose levels significantly reduced the intestinal fluid volume when compared with the control group. At the highest extract dose, aqueous extract of stem bark of A. andongensis produced the greatest reduction in volume of the intestinal fluid when compared with the other groups including the reference drug group. The median extract dose group (400 mg/kg) was comparable with the reference drug group (Table 2).

3.4. Effect of aqueous extract of stem bark of Amblygonocarpus andongensis on isolated guinea pig ileum experiment

The extract of A. andongensis effectively inhibited, in a dose related manner, the ACh-induced ileum contraction. The responses were comparable with that obtained with atropine the reference drug (Figure 2).

![Figure 1](image1.png)

**Figure 1.** Inhibitory effect of Amblygonocarpus andongensis on gastrointestinal motility. Data presented as mean\%± SEM, n= 5 for all groups. *p<0.001 compared to the aqueous acacia suspension (AAS) control group.

**Table 2:** Effect of aqueous extract of stem bark of Amblygonocarpus andongensis on PGE\(_2\)-induced enteropooling assay in rats

<table>
<thead>
<tr>
<th>Groups</th>
<th>Volume of intestinal fluid (ml)</th>
<th>Inhibition of intestinal fluid (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 mg/kg Aa</td>
<td>2.21 ± 0.13*</td>
<td>44.05</td>
</tr>
<tr>
<td>400 mg/kg Aa</td>
<td>1.35 ± 0.21**</td>
<td>65.82</td>
</tr>
<tr>
<td>600 mg/kg Aa</td>
<td>1.01 ± 0.11**</td>
<td>74.43</td>
</tr>
<tr>
<td>Loperamide</td>
<td>1.31 ± 0.12**</td>
<td>66.84</td>
</tr>
<tr>
<td>Control (vehicle)</td>
<td>3.95 ± 0.15</td>
<td>0</td>
</tr>
</tbody>
</table>

Aa= Amblygonocarpus andongensis. Data presented as mean ± S.E.M, n= 5 for all groups. *p<0.01, **p<0.001 compared with the vehicle control group.
DISCUSSION

In the present study, the anti-diarrhoeal properties of the stem bark of *Amblygonocarpus andongensis*, a plant which is widely used for the treatment of diarrhoea in the North West Nigeria was evaluated. The study was conducted against castor oil-induced diarrhoea, gastrointestinal motility and PGE$_2$ enteropooling models in Wistar rats. Isolated guinea-pig ileum experiment was used to study the antispasmodic effect of the plant in order to explore the possible mode of anti-motility effect.

Acute oral toxicity study was conducted to ascertain the safety of the plant extract on the rats. Oral administration of 3000 mg/kg of aqueous extract of *A. andongensis* to the rats did not cause any mortality or observable behavioural signs of toxicity thus suggesting that the oral LD$_{50}$ of *A. andongensis* in rats is greater than 3000 mg/kg. According to Clarke and Clarke, (1977) substances with LD$_{50}$ of 1000 mg/kg body weight are regarded as safe or of low toxicity. This suggests that the aqueous stem bark extract of *A. andongensis* may be safe or of low toxicity.

Most agents with anti-diarrhoeal potential possess anti-secretory and anti-motility effects. In order to elucidate the possible mechanism of anti-diarrhoeal potential of our extract, castor oil was used to induce diarrhoea in the rats. Castor oil is obtained from the seeds of a flowering plant *Ricinus communis* (Euphorbiaceae). The active component of castor oil is the ricinoleic acid, which is liberated from the action of lipases on castor oil (Jia *et al.*, 2008). The liberated ricinoleic acid being poorly absorbed causes local irritation and inflammation of the intestinal mucosa, leading to release of prostaglandins, which induces net secretion of water and electrolytes into the small intestine and stimulate intestinal motility (Sarin *et al.*, 2013). These lead to hypersecretory responses and diarrhoea (Kutchai, 2004; Capasso *et al.*, 1994). The secretory diarrhoea induced by castor oil is associated with an activation of Cl$^-$ channels, causing Cl$^-$ efflux from the cell. The efflux of Cl$^-$ results in considerable secretion of water into the intestinal lumen and immense watery diarrhoea. Thus, the precise mechanism of action of castor oil is through elevated prostaglandin biosynthesis (Ammon *et al.*, 1974; Galvez *et al.*, 1993). Therefore, inhibitors of
prostaglandin biosynthesis were found to delay castor oil induce diarrhoea. Loperamide, the reference drug, is a piperidine butyramide derivative with μ-opioid receptor activity and generally produces rapid and sustained inhibition of peristaltic reflex through depression of longitudinal and circular muscle activity (Sharkey and Wallace, 2011). This reduces the production of watery stool and increases the onset of defecation. The drug also possesses anti-secretory and anti-motility activities probably through intestinal opiate receptors (Craig and Stitzel, 1990; Couper, 1987). In the present study too, loperamide proved the claims by causing a delay in the onset of defecation and a reduction in production of watery stools when compared to the vehicle treated control rats. The extract effectively inhibited both the onset of diarrhoea and the number of diarrhoea faeces produced similar to loperamide, the reference drug. The significant dose-dependent reduction in castor oil-induced diarrhoea in rats is a demonstration of the efficacy of Amblygonocarpus andongensis as an anti-diarrhoea medicine. Hence, it can be assumed that the anti-diarrhoea action of this plant was exerted by anti-secretory mechanism.

In order to further elucidate the possible mechanism of anti-diarrhoeal activity of aqueous extract of stem bark of A. andongensis, it was necessary to verify its effects on GI motility. The gastrointestinal tract (GIT) is innervated by the sympathetic and parasympathetic fibers of the autonomic nervous system. Cholinergic stimulation often causes diarrhoea by increasing GI motility. The effect of the extract on GI motility was studied using activated charcoal meal as the marker. This is because activated charcoal adsorbs drugs and chemicals on the surface of the charcoal particles thereby preventing absorption. Thus, GI motility test with activated charcoal (charcoal meal test) is carried out to find out the effect of drugs on peristaltic movement. Atropine our reference drug is a parasympatholytic drug, which acts by blocking the actions of acetylcholine at muscarinic receptors. Atropine, as anti-diarrhoea, possesses anti-motility effect and acts by increasing the intestinal transit time probably due to its anti-cholinergic effect (Brown and Taylor, 2000). In the same way as the atropine, the extract significantly reduced the distance travelled by the marker in the intestine. The extract at 600 mg/kg reduced intestinal propulsion more than the reference drug. This proved that the aqueous extract of A. andongensis possess anti-motility effect, which in turn permits the absorption of water and electrolyte thus, resulting in anti-diarrhoea activity. This result obtained also suggests that A. andongensis may possess in addition to anti-motility and anti-secretory effects, some anticholinergic properties. This was further evaluated in an antispasmodic experiment using isolated guinea-pig ileum.

As it is well known, cholinergic stimulation often causes diarrhoea by increasing GI motility. Ach is a neurotransmitter from parasympathetic nervous system. It acts on muscarinic and nicotinic cholinergic receptors. It is well known that this neurotransmitter generates a contractile response in the ileum. Currently, Nitric oxide (NO) has been proposed to contribute to the inhibitory nor adrenergic, non-cholinergic neurotransmitter that mediates GI motility in physiological and certain non-pathophysiological states, such as in absorptive and secretory processes. NO could lead to gut secretion via elevation of cGMP and cAMP concentration (Liang et al., 2005). In order to study the mode of anti-motility effect of the extract, the antispasmodic experiment was carried out with ACh using guinea-pig ileum. Atropine, our reference drug, is a competitive antagonist for the muscarinic ACh receptor (Pappano and Kutzung,
In this study, *A. andongensis* as well as atropine sulphate inhibited ACh-induced contractions of isolated guinea pig ileum in the same manner. This, as well as the GI motility experiment strongly suggests that the antispasmodic activity of *A. andongensis* may involve a cholinergic mechanism.

In the PGE2-induced enteropooling experiment, *A. andongensis* reduced diarrhoea by significantly inhibiting PGE2-induced intestinal fluid accumulation. It is also well documented that loperamide, our reference drug, reduces diarrhoea due to prostaglandins and other irritants (Karim and Adaikan, 1977).

The phytochemical analysis showed the presence of tannins, flavonoids, saponins, terpenes and glycosides which have been reported to be responsible for anti-diarrhoea activities in some plants (Havagiray et al., 2004; Méité et al., 2009; Murugessan et al., 2000; Abdullahi et al., 2001; Ojewole et al., 2009). Tannins denature proteins by forming a complex (protein tannate) and this complex coats the intestinal mucosa and makes it more resistant while simultaneously diminishing gastric secretions (Westendarp, 2006). They have been reported to possess various physiological properties such as anti-secretory, anti-irritant, antimicrobial and antiparasitic (Venkatesan et al., 2005; Mukherjee et al., 1998). The anti-diarrhoeal property of flavonoids has been attributed to their ability to inhibit intestinal motility and hydro-electrolytic secretion (Di carlo et al., 1993; Rao et al., 1997; Galvez et al., 1993), which are known to be altered in diarrhoea. Various studies have shown that flavonoids are able to inhibit the intestinal secretory response, induced by PE2, inhibit electrically-induced contractions and those that are induced by certain agonists, such as Ach, 5-hydroxytryptamine (5-HT) and histamine (Sanchez de Medina et al., 1997). In addition, flavonoids possess antioxidant properties (Su et al., 2000) which are supposed to be responsible for the inhibitory effects exerted upon several enzymes including those involved in the arachidonic acid metabolism (Mora et al., 1990; Bimlesh et al., 2010). The spasmylocytic effects of flavonoids have been shown to be nonspecific in activity as they inhibit both Ach- and BaCl2-induced contractions (Sarin et al., 2013). Terpenes and terpenoids derivatives inhibit the release of autacoids and prostaglandins, thus inhibiting the secretion and motility induced by castor oil and PGE2 (Yasmeen et al., 2010). Therefore, the tannins, flavonoids and terpenes present in the aqueous stem bark extract of *A. andongensis* are thought to be responsible for anti-diarrhoeal activity by increasing colonic water and electrolyte reabsorption and inhibiting intestinal motility. It is thus suggestive that the anti-diarrhoeal activity of aqueous stem bark extract of *A. andongensis* may be due to the presence of these phytochemical constituents. The results indicate that the aqueous extract of *A. andongensis* possesses significant anti-diarrhoeal activity due to its inhibitory effect both on gastrointestinal propulsion and fluid secretion. The inhibitory effect of the extract justified the use of the plant as a non-specific anti-diarrhoeal agent in traditional medicine.

**CONCLUSION**

The aqueous extract of the stem bark of *Amblygonocarpus andongensis* possesses anti-diarrhoeal properties which may be related to its anti-secretory and anti-motility/antispasmodic activities. These results validate its use in traditional medicine for the treatment of diarrhoea. More studies are however needed to isolate and characterise the anti-diarrhoeal components in this plant.

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