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Botanical galactogogues: nutritional values and therapeutic potentials

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ABSTRACT

Objective: In view of the reported side effects of the orthodox galactogogues, this study analysed ten botanical galactogogues for their chemical constituents and antimicrobial activities with the aim of providing scientific insight into their use as galactogogues.

Methodology: The plants were identified at University of Ibadan Herbarium (UIH). Powdered plant samples were screened for chemical compositions using standard methods. The test organisms were clinical pathogenic isolates of *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Candida albicans*, *Streptococcus pyogenes* and *Staphylococcus aureus*. The ethanol extracts (50%) of samples were prepared using cold extraction method and tested *in vitro* against isolates using agar well diffusion method. *Alternanthera sessilis* had the highest (17.60 mg/100g) crude protein. *Vitex doniana* had the least (15.36 mg/100g) crude fibre. *V. doniana* contained 1.46 mg/100g of iron. *A. digitata* contained calcium (5275.00 mg/100g). *Lecaniodiscus cupanioides* showed highest (15.00 mm) activity against *Escherichia coli*. *V. doniana* was most active against *Klebsiella pneumoniae* (21.00 mm).

Conclusions and application of findings: This study has contributed to preservation of indigenous knowledge of the use of botanicals as galactogogues. The test plants may not only work as galactagogues but also carry out multifunctional activity in the nursing mother and the child. *Adansonia digitata* can be used as weaning food due to its high calcium content. *Vitex doniana* could be used as food supplement based on its iron component. It could also have therapeutic application in anaemia related diseases or health condition in nursing mother especially Insufficient Milk Supply (IMS). The plants showed therapeutic potentials against *E. coli* and *K. pneumoniae*. They could be used for the treatment of diarrhoea and pneumonia reportedly to be major causes of child mortality worldwide. Further work should confirm the activity of these plants as galactagogues. The isolation and identification of active compounds of the test plants will contribute immensely to their use as herbal drugs.

Keywords: Botanicals, galactogogues, macronutrients, micronutrients, phytochemicals, antimicrobial activity.

INTRODUCTION

Vitex doniana (Sweet) (black plum), *Kigelia africana* (Lam.) Benth. (sausage tree), *Allophylus africanus* P.Beauv (African false currant), *Alternanthera sessilis* (L.) R. Br. (sessile joyweed), *Secamone afzelii* (Schult.) K. Schum. (secamore), *Calotropis procera* (Aiton) W. T. Aiton (sodom apple), *Adansonia digitata* Linn. (baobab tree), *Lecaniodiscus cupanioides* Planch. (ginger lily), *Launaea taraxacifolia* (Willd.) Amin ex C. Jeffrey (wild lettuce), and *Senecio biafrae* Oliv. & Hiern (groundsel) are botanical galactogogues in Nigeria. Galactogogues are agents or substances that can induce or enhance breast milk secretion. They include foods, herbal medicines and pharmaceutical drugs. They can be helpful in solving milk supply issues not only by increasing milk production, but also by supporting the nursing mother's confidence (Westfall, 2003). Breastfeeding is an unequalled way of providing ideal food for healthy growth and development of infants, and exclusive breastfeeding is the optimal way of feeding infants (Kramer and Kakuma, 2002). It provides all the energy and nutrients that the infant needs for the first months of life, and it continues to provide up to half or more of a child's nutritional needs during the second half of the first year, and up to one-third during the second year of life. Breast-feeding is associated with better nutritional and non-nutritional outcomes compared with formula feeding even in case of preterm birth (Chatterton *et al*., 2000). The World Health Organisation strongly recommends exclusive breastfeeding for the first six months of life. After six months, other foods should complement breastfeeding for up to two years or more. Beyond the immediate benefits for children, breastfeeding contributes to a lifetime of good health (WHO, 2012). Lactating mothers face a variety of challenges including maintaining a sufficient milk supply (Henderson, 2003). Insufficient Milk Supply (IMS) is the major reason cited for early cessation of breastfeeding; yet actual insufficient milk supply is rare, as IMS is associated with insufficient glandular tissue, breast surgery, postpartum haemorrhage or anaemia (Riordan and Acerbic, 1998). A reduced breast milk production can occur in many circumstances, such as preterm birth, illness of the mother or the child, mother-baby separation, re-lactation after a prolonged suspension, indirect lactation (breast pump or manual milk expression), anxiety, fatigue, and emotional stress are powerful inhibitors of lactation (Zuppa *et al*., 2010). Imbalance in maternal hormone, deficiency in the breast tissue itself or most often inadequate milk removal due to poor breast feeding techniques can also reduce breast milk production (Mohrbacher and Stock, 2003). Lactating mothers should consume a well-balanced diet, maintain adequate fluid intake and avoid substances known to decrease milk supply. A diet with increased protein (Lawrence, 1999) and approximately 500 extra calories above what they need to maintain their weight will promote maximum milk production (Riordan and Auerbach, 1998). Maternal micronutrient deficiencies during lactation can cause a major reduction in the concentration of some of these nutrients in breast milk, with subsequent infant depletion (Allen and Graham, 2003). The main mineral constituents of human milk are Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Phosphorus (P), and Chlorine (Cl). Calcium concentrations reported in various studies vary from 25 - 35 mg/100 ml. Phosphorus at 13 - 16 mg/100 ml is much more constant but is lower in proportion to casein and calcium than in milks of most other animal species. Iron, copper, and zinc contents of human milk vary considerably and a long list of other trace elements has been reported. All of the vitamins except vitamin K are found in human milk in nutritionally significant concentrations (Jenness, 1979). Breast fed babies are highly protected against diseases due to antibodies present in breast milk (Newman, 1995). In addition to individual health benefits, breastfeeding may provide significant economic benefits in terms of reducing costs that may be related to visiting the physician, clinic, hospital, or medical Laboratory. Other direct economic benefits to a family may be not buying or reduced cost of buying infant formula for the first year after birth (Weimer, 2001). Some orthodox galactogogues are metoclopramide, domperidone and chlorpromazine. The side effects of metoclopramide are fatigue, irritability and depression (Starr and Starr, 1999). Domperidone has been reported to cause cardiac arrhythmia and sudden death in cancer patients treated with intravenous domperidone (Osborne *et al*., 1985). Chlorpromazine has side effects of weight gain and lethargy, sleepiness and reduced behavioural performance in infants (Henderson, 2003).

The use of natural products in inducing and increasing milk production has a long history (Zuppa, 2010) and nearly all cultures have promoted one substance or another as a galactogogue to encourage the synthesis and secretion of breast milk (Henderson, 2003). Many botanical galactogogues are derived from plant producing latex (milky sap) or whose shape resemble the breast (doctrine of signature). The drugs are, in their majority, not exclusively employed to increase the flow of breast milk but serve as multi-functional remedies (Perry, 1980), their use occasionally finds a parallel in popular veterinary practice to stimulate milk production in cattle and other mammals (Bruckner, 1993). This study was designed to evaluate the nutritional values and therapeutic potentials of ten botanical galactogogues with a view to providing scientific insight into their use.

MATERIALS AND METHODS

Ethnobotanical information: The selection of medicinal plants for this study was based on ethnobotanical information from literature and oral interview of local herb-sellers on plant used as galactogogues. The interview was carried out at a local herbal market (Bode) in Ibadan, Oyo state, Nigeria.

Collection and Identification of plant materials: *Launaea taraxacifolia* (leaf) and *Senecio biafrae* (leaf) were purchased from a local herbal market (Bode) in Ibadan, while *Vitex doniana* (fruit), *Allophylus africanus* (leaf), *Alternanthera sessilis* (leaf), *Secamone afzelii* (leaf), *Calotropis procera* (stem), *Adansonia digitata* (bark), *Lecaniodiscus cupanioides* (root), and *Kigelia africana* (fruit) were collected from University of Ibadan campus. The test plants were identified at species level in the University of Ibadan Herbarium (UIH).

Preparation of plant materials for analysis: The test plants were washed, cut into small pieces and dried at room temperature (30^oC) for three weeks until completely dried. The dry plant materials were ground into powder and stored in air-tight glass bottles at room temperature (30^oC) for further use.

Proximate analysis: The methods described in AOAC (2005) were used to analyse the proximate composition of the plants for crude protein, crude fat, crude fibre, moisture and ash while carbohydrate was calculated by subtracting the sum of the values of the other nutrients from 100.

Micronutrient analysis: Micronutrient analysis was carried out after wet digestion. The method of Walsh (1971) was used for digestion of all plant samples. After digestion Calcium (Ca), Magnesium (Mg), Copper (Cu), Zinc (Zn), Iron (Fe), Sodium (Na), Potassium (K), Manganese (Mn) were analysed using Atomic Absorption Spectrophotometer (FC 210/211 VGP Bausch scientific AAS). Phosphorus was determined using Vanadomolybdate (Yellow method.) (AOAC, 2005). Percentage transmittance was determined at 400 nm using Spectronic 20 (Bausch and Lomb) Colorimeter.

Phytochemical analysis: Phytochemical tests were carried out using standard procedure described by Harbone (1973), Sofowora (1993) and Evans (2002).

Extraction of powdered plant samples in ethanol: The powdered plant sample (50g each) was extracted in 300 ml of ethanol for 2 weeks using cold extraction methods. The extract was concentrated at 40^oC and stored in the refrigerator (4^oC) prior to use. 100 mg/ml of the extract was used for the antimicrobial screening.

Antimicrobial screening: The test organisms were clinical isolates of *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Candida albicans*, *Streptococcus pyogenes,* and *Staphylococcus aureus* obtained from University College Hospital (UCH), Ibadan. Isolates were maintained in cultures on Nutrient Agar (Quebec, Canada). The isolates were grown in nutrient broth (Quebec, Canada) for 18 h. at 35^oC. The inoculum load was adjusted to 1×10^{-3} cfu/ ml via serial dilution method prior to use. 1ml of the inoculum was thoroughly mixed with 19 ml of sterile nutrient agar and poured into sterile Petri dish (100 mm in diameter). The agar was left to solidify. A standard cork borer of 6 mm in diameter was used to cut well in each agar plate. Thirty (30) µl of each extract was filled into the wells with the aid of a sterile micropipette. Fifty (50) % ethanol was used instead of the extract in the control experiment. Also plates containing the test organisms in agar without extract were used as control. All experiments were done aseptically and each experiment was replicated three times. The plates were incubated at 37^{0}C for 36-48 hrs. The diameters of the clear zones of inhibitions were measured and the result recorded in millimetres (mm).

Statistical analysis: All data were expressed as mean ± SD and statistically analysed using One-way Analysis of Variance (ANOVA). The Duncan Multiple Range Test (DMRT) was used to test means for significance. Values were considered significant at $P < 0.05$.

RESULTS AND DISCUSSION

The profiles of the ten botanical galactogogues are presented in Table 1. The plants belong to eight different families namely: Verbenaceae, Bignoniaceae, Sapindaceae, Amaranthaceae, Asclepiadaceae, Bombacaceae, Sapindaceae, and Asteraceae. Future search for galactogogues should include the botanicals from these families most especially the Asclepiadaceae and Asteraceae which are common. The habits (life forms) of the plants were 50% trees, 40% herbs and 10% shrubs.

Table 1: Profile of botanical galactogogues used in this study

S/N	Plant	Family	Local name (Yoruba)	Plant habit	Part used
1.	*Vitex doniana*	Verbenaceae	Oori-nla	Tree	Fruits
2.	*Kigelia africana*	Bignoniaceae	Pandoro	Tree	Fruits
3.	*Allophylus africanus*	Sapindaceae	Eekan-ehoro	Small tree	Leaves
4.	*Alternanthera sessilis*	Amaranthaceae	Reku-reku	Herb	Leaves
5.	*Secamone afzelii*	Asclepiadaceae	Arilu,alu	Herb	Leaves
6.	*Calotropis procera*	Asclepiadaceae	Bomubomu	Shrub	Stems
7.	*Adansonia digitata*	Bombacaceae	Ose	Tree	Barks
8.	*Lecaniodiscus cupanioides*	Sapindaceae	Akika	Small tree	Roots
9.	*Launaea taraxacifolia*	Asteraceae	Yanrin	Herb	Leaves
10.	*Senecio biafrae*	Asteraceae	Worowo	Herb	Leaves

Table 2 shows the indigenous recipes and their methods of preparation and administration. The methods of preparation are decoction, concoction and paste. The decoctions are taken orally, concoction are eaten as vegetable and paste are applied topically on the breast.

Table 2: Method of preparation and administration of indigenous galactogogue recipes

S/N	Herbal combination and dosage (ml)	Method of preparation
1	*Vitex doniana* fruits and leaves are boiled in water and 200 ml taken three times daily after meal to induce lactation.	Decoction
2	The ripe fruit of *Kigelia africana* is made into a paste and massaged on the breast. A decoction (200 ml) of the fruit is taken twice daily to induce secretion of breast milk.	Decoction and paste
3	The bark and leaves of *Allophylus africanus* are boiled in water and 200 ml taken twice daily after meal.	Decoction
4	The leaves of *Alternanthera sessilis* are eaten as vegetable in soup to enhance secretion of breast milk. The leaves could also be squeezed in water as drink.	Concoction
5	*Secamone afzelii* leaves are made into paste and rubbed on the breast.	Paste
6	Stems of *Calotropis procera* are boiled in water and 150 ml taken twice daily after meal.	Decoction
7	The bark of *Adansonia digitata* is boiled in water and 200 ml taken twice daily after meal.	Decoction
8	The roots of *Lecaniodiscus cupanioides* are boiled in water and 100 ml taken twice daily after meal.	Decoction
9	Leaves of *Launaea taraxacifolia* are eaten as vegetable in soup.	Concoction
10	Leaves of *Senecio biafrae* are eaten as vegetable in soup.	Concoction

The proximate analysis revealed that some of the plants were high in protein (Table 3). The crude protein content of *A. sessilis* (17.60%) was significantly high and the least (9.79%) was from *A. digitata*. Food that provide more than 12% of the calorific value from protein are good sources of protein and proteins are very important molecules in human being and are involved in virtually all cell functions (Lioyd, 2012), in that context *Vitex doniana, Allophylus africanus, Alternanthera sessilis, Secamone afzelii, Launaea taraxacifolia* and *Senecio biafrae* are good sources of protein. Crude fat was highest in *C. procera* (8.64%) followed by *S. afzelii* (7.05%) while *A. digitata* (3.62%) had the lowest.

Table 3: Proximate compositions of ten botanical galactogogues

Plant	Crude protein (%)	Crude fat (%)	Crude fibre (%)	Moisture (%)	Ash (%)	Carbo-hydrate (%)
Vitex doniana	*12.38^{f} ±0.10	5.13^{f} ±0.03	15.36^{i} ±0.03	9.13^{g} ±0.02	6.06^{e} ±0.02	51.94^{b} ±0.05
Kigelia Africana	6.74^{i} ±0.004	3.66^{i} ±0.03	36.83^{a} ±0.02	9.29^{f} ±0.03	4.91^{g} ±0.03	27.22^{j} ±0.09
Allophylus africanus	16.91^{b} ±0.05	6.82^{c} ±0.03	17.76^{d} ±0.03	9.54^{d} ±0.02	11.84^{b}±0.02	37.13^{i} ±0.12
Alternanthera sessilis	17.60^{a} ±0.06	5.61^{e} ±0.03	16.41^{g} ±0.03	9.26^{f} ±0.03	12.44^{a}±0.00	38.67^{g} ±0.45
Secamone afzelii	15.89^{c} ±0.10	7.05^{b} ±0.03	17.27^{e} ±0.03	9.70^{c} ±0.00	11.96^{b}±0.00	38.13^{h} ±0.11
Calotropis procera	9.39^{g} ±0.07	8.64^{a} ±0.03	21.52^{c} ±0.03	9.94^{a} ±0.02	5.34^{f} ±0.03	45.17^{e} ±0.10
Adansonia digitata	5.52^{j} ±0.04	3.62^{i} ±0.03	16.94^{f} ±0.03	9.79^{b} ±0.03	4.07^{h} ±0.02	60.06^{a} ±0.10
Lecaniodiscus cupanioides	7.29^{h} ±0.06	6.17^{d} ±0.02	29.47^{b} ±0.02	9.21^{f} ±0.04	3.51^{i} ±0.02	44.35^{f} ±0.07
Launaea taraxacifolia	13.47^{d} ±0.09	4.73^{g} ±0.03	15.54^{h} ±0.02	9.15^{g} ±0.04	9.86^{c} ±0.02	47.25^{d} ±0.11
Senecio biafrae	12.94^{e} ±0.02	4.33^{h} ±0.03	17.23^{e} ±0.02	9.43^{e} ±0.04	6.20^{d} ±0.02	49.87^{c} ±0.07

Legend: Values are mean ± SD of three replicates. Test values in the same column with same superscripts are not significantly different at $P < 0.05$.

The high crude fat observed in *C. procera* and *S. afzelii* may be due to the considerable amount of latex present in two plants; this may be an indication that latex-producing plants are high in crude fat. Fats are the principal sources of energy and one gram of lipid provides 9.0 Kcal (37.33 KJ) of energy (FAO, 2003). The highest crude fibre was observed in *K. africana* (36.83%) followed by *L. cupanioides* (29.47%) and *V. doniana* (15.36%) had the lowest. Crude fibre is an important part of diet and decreases serum cholesterol level, risk of coronary heart disease, hypertension, diabetes, colon and breast cancer (Ishida *et al.,* 2000). This indicates that the fibre (roughage) content of these plants such as *K. africana, L. cupanioides, and C. procera* will promote digestion and prevent constipation when consumed.

The plant samples contained varied amount of micronutrients (Table 4). Sodium (Na) content was highest in *A. sessilis* (646.00 mg/100g) followed by *C. procera* (533.00 mg/100g) and *L. cupanioides* had the lowest (13.60 mg/100g). The highest calcium (Ca) content was from *A. digitata* (5275.00 mg/100g) followed by *S. afzelii* (4050.00 mg/100g) and the least (45.00 mg/ 100g) from *V. doniana*. The high amount of calcium in the bark of *A. digitata* is in agreement with the report of Lockett *et al.* (2000) who reported that the bark of *A. digitata* was high in calcium. Calcium rich plants in diets are known to aid strong bones and healthy teeth formation. Iron content *was* highest *in V. doniana* (1.46 mg/100g) followed by *A. sessilis* (0.777 mg/100g) and *K. africana* had the least (0.12 mg/100g). The Iron constituent in *Vitex doniana* in this study agrees with the report of Nnamani *et al.* (2009) that the amount of iron in *V. doniana* leaves was less than 4 mg/100g. Intake of food rich in iron will prevent anaemia and fatigue.

Table 4: Micronutrient components of ten botanical galactogogues (mg/100g)

Plant	Na	Ca	Fe	P	K	Zn	Cu	Mg	Mn
Vitex doniana	*27.70^{h} ±0.01	45.00^{j} ±0.20	1.46^{a} ±0.01	65.60^{i} ±0.35	228.50^{e} ±0.11	1.69^{h} ±0.00	0.65^{f} ±0.00	129.00^{j} ±0.15	0.40^{i} ±0.01
Kigelia Africana	41.10^{f} ±0.02	446.00^{i} ±0.06	0.12^{j} ±0.00	72.20^{g} ±0.17	79.30^{h} ±0.04	1.70^{h} ±0.01	1.03^{d} ±0.00	165.00^{i} ±0.16	0.20^{j} ±0.01
Allophylus africanus	30.10^{g} ±0.02	2305.00^{e} ±0.12	0.30^{e} ±0.00	109.40^{c} ±0.20	77.80^{i} ±0.01	5.01^{d} ±0.02	1.04^{d} ±0.00	662.00^{c} ±0.06	8.20^{c} ±0.01
Alternanthera sessilis	646.00^{a} ±0.20	2770.00^{c} ±0.93	0.777^{b} ±0.00	94.10^{e} ±0.15	668.50^{b} ±0.47	9.81^{a} ±0.02	1.77^{c} ±0.00	1195.00^{a} ±0.01	19.30^{a} ±0.01
Secamone afzelii	345.00^{c} ±0.20	4050.00^{b} ±0.17	0.26^{f} ±0.00	98.40^{d} ±0.10	295.00^{d} ±0.06	2.97^{f} ±0.01	2.03^{a} ±0.00	658.00^{d} ±0.22	16.10^{b} ±0.01
Calotropis procera	533.00^{b} ±0.10	1465.00^{g} ±1.53	0.19^{h} ±0.00	91.90^{f} ±0.15	221.50^{f} ±0.10	2.74^{g} ±0.00	0.94^{e} ±0.00	543.00^{f} ±0.82	3.80^{f} ±0.01
Adansonia digitata	19.40^{i} ±0.01	5275.00^{a} ±2.91	0.21^{g} ±0.00	70.00^{h} ±0.07	191.00^{g} ±0.01	3.82^{e} ±0.01	0.67^{f} ±0.00	714.50^{b} ±0.41	7.80^{d} ±0.01
Lecaniodiscus cupanioides	13.60^{j} ±0.02	450.00^{h} ±2.52	0.18^{i} ±0.00	21.90^{j} ±1.18	33.50^{j} ±0.01	1.64^{i} ±0.02	0.57^{g} ±0.00	341.50^{h} ±0.32	1.30^{h} ±0.03
Launaea taraxacifolia	237.00^{d} ±0.01	2315.00^{d} ±0.15	0.43^{d} ±0.00	123.00^{b} ±0.06	1044.00^{a} ±0.01	5.89^{c} ±0.01	1.92^{b} ±0.00	391.00^{g} ±1.29	4.80^{e} ±0.03
Senecio biafrae	90.80^{e} ±0.01	2110.00^{f} ±0.53	0.75^{c} ±0.02	155.30^{a} ±0.05	574.00^{c} ±0.06	8.41^{b} ±0.01	1.89^{b} ±0.00	550.00^{e} ±0.36	3.20^{g} ±0.01

Legend: Values are mean ± SD of three replicates. Test values in the same column with same superscripts are not significantly different at $P < 0.05$.

The plant samples contained alkaloids, tannins, β carotene, saponins, and steroids in varied quantities (Table 5). The percentage phytochemical was low and in all cases less than 3.0 percent. This agrees with the report of Dike (2010) who recorded between 0.00 - 4.14 % phytochemicals in the fruits, seeds and leaves of some plant species (*Adansonia digitata* and *Lecaniodiscus cupanioides*). Alkaloids were highest in *L. cupanioides* (1.15%) and lowest in *C. procera* (0.33%). Alkaloids are known to play some metabolic role and control development in living system. It also has protective role in animals and used in medicine especially the steroidal alkaloids that constitute most of the valuable drugs (Edeoga *et al*., 2006). The amount of tannins was highest in *V. doniana* (0.040%) and *K. africana* (0.014%) had the least. *A. sessilis* (1486.55 µg/100g) had the highest amount of β carotene and *A. digitata* (6.30 µg/100g) had the least. Tannins hasten the healing of wounds and inflamed mucus membrane, hence herbs possessing tannins are widely used as mouth wash, eye washes, snuff, vaginal douches and also to treat rectal disorder. Although, long term and excessive use of herbal vegetable containing high concentration of tannins is not recommended because when applied internally, tannins affect the walls of the stomach and other digestive parts, they sour the mucus secretions and contract or squeeze the membranes in such a manner that secretions from the cells are restricted (Okwu and Okwu, 2004). All the test plants had steroid, although in minute quantities. The presence of steroid may enhance the use of the plants as galactogogues by ensuring the synthesis of lactation hormones. According to Okwu (2001), steroids increase protein synthesis, promote growth of muscles and bones, and that steroidal compounds are of importance and interest in pharmacy due to their relationship with compounds such as sex hormones. Saponin was highest in *L. cupanioides* (2.53%) and *C. procera* had the least (0.54%). Saponins are produced by plants as defence mechanism to stop attack by foreign pathogen, thus making them to be natural antibiotics. Studies have shown that saponins can generate adverse physiological responses in animals that consume them. They exhibit cytotoxic effect and growth inhibition against a variety of cells, making them to have anti-inflammatory and anticancer properties (Iniaghe *et al.*, 2009). They also show tumour inhibiting activity on animals (Akindahunsi and Salawu, 2005).

Table 5: Phytochemical compositions of ten botanical galactogogues

Plant	Alkaloids (%)	Tannins (%)	β-carotene (µg/s100g)	Saponin (%)	Flavonoids (%)	Steroids (%)	Cardenolides (%)	Anthraquinones (%)	Glycosides (%)	Phenol (%)
Vitex doniana	*0.37^{l} ±0.020	0.040^{a} ±0.001	682.43^{e} ±0.02	0.75^{f} ±0.01	0.002^{c} ±0.000	0.003^{f} ±0.000	0.006^{a} ±0.000	0.000^{g} ±0.000	0.400^{f} ±0.010	0.085^{a} ±0.002
Kigelia Africana	1.03^{b} ±0.010	0.014^{g} ±0.003	11.35^{i} ±0.03	2.35^{b} ±0.03	0.000^{d} ±0.000	0.001^{h} ±0.000	0.000^{d} ±0.000	0.000^{g} ±0.000	0.780^{a} ±0.030	0.040^{d} ±0.001
Allophylus africanus	0.56^{f} ±0.020	0.023^{e} ±0.002	1346.64^{b} ±0.03	0.86^{e} ±0.03	0.006^{a} ±0.000	0.004^{e} ±0.000	0.000^{d} ±0.000	0.066^{b} ±0.002	0.350^{g} ±0.020	0.047^{c} ± 0.002
Alternanthera sessilis	0.80^{c} ±0.010	0.018^{f} ±0.001	1486.55^{a} ± 0.02	1.23^{c} ±0.03	0.002^{c} ±0.000	0.007^{b} ±0.000	0.000^{d} ±0.000	0.033^{e} ±0.002	0.650^{b} ±0.020	0.056^{b} ±0.003
Secamone afzelii	0.61^{e} ±0.020	0.032^{c} ±0.001	1296.55^{c} ±0.03	0.95^{d} ±0.02	0.003^{b} ±0.000	0.005^{d} ±0.000	0.000^{d} ±0.000	0.048^{c} ±0.001	0.470^{d} ±0.020	0.059^{b} ±0.002
Calotropis procera	0.33^{i} ±0.055	0.019^{f} ±0.002	32.66^{h} ±0.03	0.54^{h} ±0.03	0.000^{d} ±0.02	0.003^{f} ±0.000	0.004^{b} ±0.000	0.035^{e} ±0.002	0.430^{e} ±0.010	0.042^{d} ±0.002
Adansonia digitata	0.71^{d} ±0.023	0.026^{de} ±0.001	6.30^{j} ±0.02	0.93^{d} ±0.02	0.000^{d} ±0.000	0.008^{a} ±0.000	0.000^{d} ±0.000	0.070^{a} ±0.003	0.510^{c} ±0.020	0.051^{c} ±0.002
Lecaniodiscus cupanioides	1.15^{a} ±0.022	0.016^{fg} ±0.002	33.62^{g} ±0.02	2.53^{a} ±0.02	0.003^{b} ±0.000	0.002^{g} ±0.000	0.003^{c} ±0.000	0.031^{f} ±0.003	0.000^{h} ±0.000	0.034^{e} ±0.002
Launaea taraxacifolia	0.51^{g} ±0.031	0.028^{d} ±0.001	796.25^{d} ±0.02	0.66^{g} ±0.04	0.002^{c} ±0.000	0.006^{c} ±0.000	0.000^{d} ±0.000	0.035^{e} ±0.002	0.380^{fg} ±0.010	0.055^{b} ±0.003
Senecio biafrae	0.46^{h} ±0.033	0.035^{b} ±0.001	658.27^{f} ±0.02	0.74^{f} ±0.03	0.000^{d} ±0.000	0.006^{c} ±0.000	0.000^{d} ±0.000	0.041^{d} ±0.003	0.000^{h} ±0.000	0.081^{a} ±0.003

Legend: Values are mean ± SD of three replicates. Test values in the same column with same superscripts are not significantly different at $P < 0.05$.

Table 6 shows the inhibitory behaviour of the ten herbal galactogogues against six pathogenic organisms. Nine (9) out of the 10 extracts were active against *E. coli*, the highest activity of 15.00 mm zone of inhibition was observed for *L. cupanioides* while the least was observed for *S. biafrae* (11.0 mm) and *K. africana* (11.0 mm) with no significant difference between them. Six (6) out of the 10 extracts were active on *K. pneumoniae*, the highest zones of inhibition was observed for *V. doniana* (21.0 mm) and *K. africana* (19.0 mm) with no significant difference between them, the least was observed in *C. procera* (11.0 mm). The activity of *V. doniana* against *K. pneumoniae* agrees with the report of Egharevba *et al*. (2010). Four (4) of the ten extracts were active against *P. aeruginosa*, the highest activity of 17.0 mm zone of inhibition was observed for *L. taraxacifolia*. Three (3) of the ten extracts were active against *C. albicans*, but there was no significant difference between the zones of inhibition for *A. digitata* (19.0 mm), *V. doniana* (17.0 mm) and *C. procera* (16.0 mm). Some anti-candidal plants reported by Gbadamosi (2008) are *Aristolochia bracteolata, Calliandra portoricensis, Curculigo pilosa, Gladiolus dalenii* and *Plumbago zeylanica*. *A. sessilis* was the only plant extract active against *S. pyogenes* with 23.0 mm zone of inhibition. This might be an indication that it has component that could successfully inhibit the growth of *S. pyogenes,* since all the other extracts were not active against it. The antimicrobial activity of *A. sessilis* against *S. pyogenes* agrees with the report of Johnson *et al*. (2010) that the leaf extract had high activity against *S. pyogenes*. Three (3) of the 10 extracts were active against *S. aureus*, the highest activity of 19.00 mm zone of inhibition was observed for *A. africanus* while the lowest inhibition of 15 mm was observed for *L. cupanioides.*The high activity of *A. africanus* against *S. aureus* agrees with the finding of Sofidiya *et al*. (2011). The activity of *Calotropis procera* against *E. coli*, *S. aureus*, *P. aeruginosa, and C. albicans* agrees with the report of Goyal and Mathur (2011) that *Calotropis procera* has good inhibition against *E. coli*, *P. aeruginosa*, *S. aureus* and *C. albicans*.

Table 6: Inhibitory behaviour of ten botanical galactogogues against six pathogenic organisms (10^{-3}cfu/ml)

Plant extract (100 mg/ml)	***Escherichia Coli***	***Klebsiella pneumoniae***	***Pseudomonas aeruginosa***	***Candida albicans***	***Streptococcus Pyogenes***	***Staphylococcus aureus***
	Zones of inhibition(mm)					
Vitex doniana	*13.00[bc] ±1.00	21.00[a] ±1.51	11.00[c] ±0.59	17.00[a] ±1.30	-	-
Kigelia africana	11.00[d] ±0.58	19.00[a] ±2.50	-	-	-	-
Allophylus africanus	14.00[ab] ±0.00	12.00[b] ±0.58	13.00[b] ±1.20	-	-	19.00[a] ±4.00
Alternanthera sessilis	14.00[ab] ±1.00	13.00[b] ±0.60	-	-	23.00[a] ±2.00	16.00[ab] ±3.10
Secamone afzelii	13.00[bc] ±1.00	12.00[b] ±1.30	-	-	-	-
Calotropis procera	13.00[bc] ±1.20	11.00[b] ±0.58	11.00[c] ±0.40	16.00[a] ±1.50	–	–
Adansonia digitata	–	–	-	19.00[a] ±1.00	–	–
Lecaniodiscus cupanioides	15.00[a] ±1.00	–	–	–	–	15.00[b] ±1.50
Launaea taraxacifolia	12.00[cd] ±1.00	–	17.00[a] ±2.53	–	–	–
Senecio biafrae	11.00[d] ±0.58	–	–	–	–	–

Legends: – = Not Active. * Values are mean ± SD of three replicates. Test values in the same column with same superscripts are not significantly different at $P < 0.05$.

CONCLUSION

The botanicals studied may not only act as galactogogues but have multifunctional effect such as provision of required nutrients, relief from constipation and prevention of infections in the nursing mothers. Most of the plants possess therapeutic potentials against *E. coli* and *K. pneumoniae* and they could be used as herbal drugs for the treatment of diarrhoea and pneumonia which reportedly are the main causes of child mortality worldwide. The plants have potentials as food supplements for lactating mothers and babies due to their micronutrient and macronutrient constituents. *A. digitata* could also be used as weaning food due to its high calcium content. Further work should be done on isolation and identification of active compounds from the test plants. The toxicity test of the plant samples would guarantee their safety in administration.

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