Antifertility and anti-implantation potential of *Croton menyharthii* and *Uvariodendron kirkii* aqueous extract in female winstar rats

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Abstract

Unintended pregnancies pose a substantial risk to mothers and are a contributing factor to unsafe abortions carried out yearly. Four hundred and sixty five thousand abortions were carried out in Kenya in 2012. Inadequate access to contraceptive method of choice is dire in rural parts of Kenya. The unmet need contributes to the high percentage of unsafe abortions in Kenya. Root bark decoctions of *Croton menyharthii* and *Uvariodendron kirkii* are traditionally used as fertility regulators. The objective of the study was to validate the anti-fertility efficacy of both plant extracts. The effect of both plant extracts on reproductive parameters was studied using female winstar rats. Both plant extracts significantly disrupted the estrus cycle compared to the control. The extracts caused a dose related significant reduction in fertility and implantation index compared to the control. Both plants prolonged the gestation length, reduced litter size and had a non-significant effect on body weight. Both plants have potential as anti-fertility agents. However reproductive hormonal assays, uterine and ovarian histo-morphological studies and phytochemical isolation need to be carried out to further explore the anti-fertility mechanism of action in order to address the call for novel contraceptive drugs.

1. Introduction

Fertility regulation is an important economic and social determinant of women quality of life. Unfortunately married women do not have access to contraceptive method of choice especially in rural parts of Kenya (Ochako et al., 2015). Single women and adolescents rarely have access and are often excluded from contraceptive services (Ochako et al., 2015). Globally 205 million pregnancies are unintended (Ali et al., 2016; Adetunji, 2011). Twenty million unsafe abortions are carried out yearly; 97% of the unsafe abortions are in developing countries (Ali et al., 2016; Ochako et al., 2015).

Steroid and non-steroidal contraceptives though highly potent are not devoid of side effects (Darroch and Singh, 2013). It is therefore imperative to explore plant fertility regulators to improve the contraceptive pool. *Croton menyharthii* and *Uvariodendron kirkii* are indigenous in Tana River County, Kenya. Root bark decoctions from both plants are
traditionally used as fertility regulators (Kaingu et al., 2017).

The aim of the study was to evaluate the anti-fertility and anti-implantation properties of both plants extracts in female rats.

1.1 Objectives of the research
The objective was to validate the traditional claims by evaluating the anti-fertility and anti-implantation properties of both plant extracts using female winstar rats.

1.2 Justification of the research
Un-intended pregnancies pose a substantial risk to mothers and are a contributing factor to unsafe abortions (Yazdkhasti et al., 2015). Four hundred and sixty five thousand abortions were carried out in Kenya in 2012 (Shukri et al., 2015). Inadequate access to contraceptive method of choice in rural parts of Kenya is a significant contributing factor of un-intended pregnancy. The unmet contraceptive need contributes to the high percentage of unsafe abortions in Kenya. Root bark decoctions from both plants are used to confer contraceptive effect. It was therefore imperative to scientifically validate the traditional claims and in so doing possibly come up with novel contraceptive compounds that would contribute in addressing the national concern on un-intended pregnancies.

2. Materials and methods

2.1 Plant collection, identification, extract preparation and experimental animals
Croton menyharthii (CK021) and Uvariodendron kirkii (CK008) fresh roots were collected and identified as described by Kaingu et al., 2017. The aqueous extract was prepared as described by Kaingu et al., 2017. The aqueous extract yield for Croton menyharthii and Uvariodendron kirkii was 83.89 and 118.93 grams respectively.

Twenty five mature cyclic female winstar rats weighing between 220± 20 were used. Fresh vaginal wash samples were collected daily between 9-10am for the first 10 days and monitored for specific cytological features that distinguished the four stages of the estrus cycles (diestrus, proestrus, estrus and metestrus).

2.2 Effect of Croton menyharthii and Uvariodendron kirkii aqueous extract on estrus cycle
The effect of Croton menyharthii and Uvariodendron kirkii aqueous extract on estrus cycle was evaluated using twenty five rats. The rats were divided into 5 groups of 5 rats each. Of these five rats were used as negative control and received 0.5ml physiological saline through intra-abdominal gavage for 20 days. Groups 2 and 3 received 500 and 800 mg/ Kg Croton menyharthii aqueous extract daily for 20 days; Group 4 and 5 received 500 and 800 mg/Kg Uvariodendron kirkii aqueous extract through intra-abdominal gavage daily for 20 days. Vaginal wash samples were collected daily between 9 and 10am and examined for estrus cycle cytological features. These animals were not mated even though male rats were kept in the same room but in different cages.

2.3 Effect of Croton menyharthii and Uvariodendron kirkii aqueous extracts on reproductive parameters
The antifertility efficacy of the two plants on mating success, fertility index, gestation length, litter size and body weight was evaluated using 3 treatment regimes on normocyclic female winstar rats aged between 50-60 days. Male rats were introduced into female cages at the ratio of 1 male per 2 females at the appropriate time. A total of 96 rats were used. They were divided into 3 Groups (1, 2 and 3) with 32 rats each. The first day of gestation was taken to be the day spermatozoa were detected in the vaginal smear under the light microscope.
2.3.1 Effect of Croton menyharthii and Uvariodendron kirkii aqueous extracts before mating.
Thirty two rats were used. The rats were further divided into 4 subgroups (A, B, C, D) with 8 rats each. Group 1 (sub group A and B), received 500 and 800 mg/Kg of Croton menyharthii respectively. Group 1 (Subgroup C and D), received 500 and 800 mg/kg Uvariodendron kirkii respectively. The extract was administered for 14 days through intra-abdominal gavage after which the rats were mated.

2.3.2 Effect of Croton menyharthii and Uvariodendron kirkii aqueous extracts after mating.
Thirty two female rats were used. The rats were further divided into 4 subgroups (A, B, C, D) with 8 rats each. All the rats were first mated after which Group 2 (sub group A and B) received 500 and 800 mg/Kg of Croton menyharthii aqueous extract respectively and Subgroup C and D received 500 and 800 mg/Kg Uvariodendron kirkii respectively for 14 days.

2.3.3 Effect of Croton menyharthii and Uvariodendron kirkii aqueous extracts before and after mating.
Thirty two female rats were used. The rats were further divided into 4 subgroups (A, B, C, D) with 8 rats each. Group 3 (sub group A and B), received 500 and 800 mg/Kg of Croton menyharthii aqueous extract respectively and Subgroup C and D received 500 and 800 mg/Kg Uvariodendron kirkii respectively. The extract was administered for 14 days through intra-abdominal gavage after which the rats were mated. Extract administration was continued after mating until end of gestation.

2.3.4 Effect of Croton menyharthii and Uvariodendron kirkii aqueous extracts on negative and positive control rats.
Control groups consisted of eighteen negative control rats that received 0.5ml physiological saline through intra-abdominal gavage daily in 3 treatment protocols as in the experimental animals above. Six positive control rats received a subcutaneous injection of estrogen/progesterone combination (15µg estradiol / 0.15 mg progesterone) once. Both negative and positive control animals were then mated. Gestation length, litter sizes as well as body weights of all animals were noted.

2.4 Effects of Croton menyharthii and Uvariodendron kirkii aqueous extracts on implantation activity.
The effect of both plant aqueous extract on anti-implantation was determined using three rats from Group 1 (subgroup A,B,C,D) Group 2 (subgroup A,B,C,D) and Group 3 (subgroup A,B,C,D). Three rats from each of the above subgroups were selected randomly on day 7 of pregnancy and given 0.25% Evans blue dye via the tail vein. Fifteen minutes later, the rats were sacrificed. The uteri were quickly opened and assessment of implantation sites was carried out by counting the number of uterine dye sites in each uterine horn. Anti-implantation activity (%) was calculated as number of implants in control group minus number of implants in test group divided by number of implants in control group multiplied by 100.

3. Results and discussion

3.1 Effect of Croton menyharthii and Uvariodendron kirkii aqueous extract on estrus cycle
The estrus cycle was disrupted with a significant (P<0.001) prolonged diestrus and metestrus phases (Figure 1) compared to the negative control. This was followed by a significant (P<0.001) subsequent lowering of the frequency at which estrus and proestrus phases appeared (Figure 1). Uvariodendron kirkii and Croton menyharthii extract further caused a significant (P<0.001; P<0.01) delay in mating success at both dose levels compared to the negative control (Table 1). Rats took an average of 4 estrus cycles at
**Table 1:** The table shows the effect of *Croton menyharthii* and *Uvariodendron kirkii* extracts on reproductive parameters.

<table>
<thead>
<tr>
<th></th>
<th>Mating success (%)</th>
<th>Anti-fertility activity (%)</th>
<th>Gestation length (days)</th>
<th>Litter size (number)</th>
<th>Body weight (g)</th>
<th>AIA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1 (extract administration before mating)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative control</td>
<td>100</td>
<td>100</td>
<td>22 ± 0.01</td>
<td>10</td>
<td>231 ± 0.01</td>
<td>0</td>
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<tr>
<td>CM 500 mg/Kg</td>
<td>100</td>
<td>40</td>
<td>22.5 ± 0.05</td>
<td>5</td>
<td>271.6 ± 0.01</td>
<td>58.5</td>
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<tr>
<td>CM 800 mg/Kg</td>
<td>100</td>
<td>50</td>
<td>26 ± 0.02</td>
<td>6</td>
<td>268.4 ± 0.02</td>
<td>74.8</td>
</tr>
<tr>
<td>UK 500 mg/kg</td>
<td>80</td>
<td>33</td>
<td>24 ± 0.01</td>
<td>3</td>
<td>272 ± 0.02</td>
<td>67.1</td>
</tr>
<tr>
<td>UK 800 mg/Kg</td>
<td>100</td>
<td>20</td>
<td>22 ± 0.03</td>
<td>2</td>
<td>249.8 ± 0.01</td>
<td>81.3</td>
</tr>
<tr>
<td><strong>Group 2 (extract administration after mating)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative control</td>
<td>100</td>
<td>100</td>
<td>23 ± 0.01</td>
<td>11</td>
<td>274 ± 0.01</td>
<td>0</td>
</tr>
<tr>
<td>CM 500 mg/Kg</td>
<td>100</td>
<td>97</td>
<td>31 ± 0.02</td>
<td>9</td>
<td>256 ± 0.01</td>
<td>1</td>
</tr>
<tr>
<td>CM 800 mg/Kg</td>
<td>100</td>
<td>90</td>
<td>34 ± 0.05</td>
<td>10</td>
<td>248 ± 0.03</td>
<td>10</td>
</tr>
<tr>
<td>UK 500 mg/kg</td>
<td>100</td>
<td>96</td>
<td>27 ± 0.02</td>
<td>8</td>
<td>261 ± 0.01</td>
<td>2</td>
</tr>
<tr>
<td>UK 800 mg/Kg</td>
<td>100</td>
<td>93</td>
<td>22 ± 0.01</td>
<td>8</td>
<td>244 ± 0.02</td>
<td>6.2</td>
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<tr>
<td><strong>Group 3 (extract administration before and after mating)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative control</td>
<td>100</td>
<td>100</td>
<td>20 ± 0.05</td>
<td>9</td>
<td>241 ± 0.01</td>
<td>0</td>
</tr>
<tr>
<td>CM 500 mg/Kg</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>215 ± 0.05</td>
<td>68</td>
</tr>
<tr>
<td>CM 800 mg/Kg</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>221 ± 0.03</td>
<td>100</td>
</tr>
<tr>
<td>UK 500 mg/kg</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>215 ± 0.01</td>
<td>100</td>
</tr>
<tr>
<td>UK 800 mg/Kg</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>209 ± 0.01</td>
<td>100</td>
</tr>
</tbody>
</table>

AIA- Anti-implantation activity. CM-Croton menyharthii UK-Uvariodendron kirkii
**Figure 1:** The figure shows the effect of both plant extracts on estrus cycle. The cycles were disrupted with significant (P< 0.001) prolonged metestrus and diestrus phases with subsequent significant (P<0.01) reduction in proestrus and estrus cycles compared to the control.

CM- Croton menyharthii UK-Uvariodendron kirkii

**Figure 2:** The figure shows the effect of administering the extract before mating on implantation. 500 and 800 mg/Kg Croton menyharthii caused a significant (P<0.01) anti-implantation activity of 58.7% and 48.5 % respectively compared to the negative control (0%). 500 and 800 mg/Kg Uvariodendron kirkii caused a significant (P<0.001) anti-implantation activity of 67.1% and 81.3% respectively compared to the negative control (0%).

**Premating anti-implantation activity (%)**

UK- Uvariodendron kirkii CM- Croton menyharthii

**Figure 3:** The figure shows the effect of administering the extract before and after mating the rats on implantation. The figure shows a significant (P<0.01) anti-implantation activity of 68% at 500mg/Kg and (P<0.001) 100 % at 800mg/Kg by Croton menyharthii respectively compared to the negative control. 500 and 800 mg/Kg Uvariodendron kirkii caused a
significant (P<0.001) anti-implantation activity of 100% and 100% respectively compared to the negative control (0%).

**Figure 4:** The figure shows the effect of administering the extract after mating the rats on implantation. *Croton menyharthii* and *Uvariodendron kirkii* at 500 and 800 mg/Kg caused a non-significant anti-implantation activity of 1%, 10%, 2% and 6.2% respectively compared to the negative control (0%).

**UK-Uvariodendron kirkii CM-Croton menyharthii**

800mg/Kg and 3 at 500 mg/Kg *Uvariodendron kirkii* before successfully mating compared to the 1 estrus cycle for the negative control. They also took an average of 3 estrus cycles at 800mg/Kg and 2 at 500 mg/Kg *Croton menyharthii* before successfully mating compared to the negative control.

*Uvariodendron kirkii* and *Croton menyharthii* aqueous extract further caused a significant (P<0.01) delay in mating success at both dose levels compared to the negative control (Table 1). Estrus cycle is driven by both pituitary gonadotropins and ovarian steroid hormones. A disruption or disturbance of hormonal balance especially estradiol disrupts the estrus cycle (Varshney et al., 2016). Levels of estradiol start increasing as follicle stimulating hormone secretion gradually increases and initiates antral follicular growth and maturation. Rising levels of estradiol plays a major role in endometrial receptivity to implantation. Several studies corroborate these results. *Anethum graveliolis* disrupted the estrus cycle and prolonged diestrus phase.
(Monsefi et al., 2012); *Piper longum* Linn caused a significant disruption of the estrus cycle (Thakur et al., 2009); *Ficus asperifolia* disrupted estrus cycle with high frequency appearance of proestrus and estrus phase (Esther et al., 2013); *Nelumbo nucifera* caused a significant prolonged diestrus phase (Mutreja et al., 2008); *Jatropha curcus* seeds arrests the estrus cycle at diestrus phase (Dheeraj et al., 2010). This study is in contrast to (Kage et al., 2009) who reported significant prolonged estrus and metestrus phase and a reduced diestrus estrus phase due to effects of *Trichosanthes cucumerina*.

3.2 Effect of *Croton menyharthii* and *Uvariodendron kirkii* aqueous extract on reproductive parameters

3.2.1 Effect of *Croton menyharthii* and *Uvariodendron kirkii* aqueous extract before mating

Following the premating treatment regime; *Croton menyharthii* at 500 and 800 mg/Kg caused 100% mating success respectively with a significant (P<0.05; P<0.01) reduction in fertility index at 50% and 40% respectively. *Uvariodendron kirkii* aqueous extract at 500 and 800 mg/Kg caused an 80% and 100% mating success respectively with a significant (P<0.01; P<0.001) reduction in fertility index at 33% and 20 % respectively (Table 1). *Croton menyharthii* at 800mg/Kg and *Uvariodendron kirkii* at 500mg/Kg caused a significant (P<0.05) prolongation of the gestation length compared to the control (22 ± 1).

*Uvariodendron kirkii* and *Croton menyharthii* aqueous extract at 500 and 800mg/Kg caused a significant reduction (P<0.001) in litter size (Table 1). The rats gained weight during the 14 days premating extract administration. The reduction in fertility index was dose dependent with a significant reduction at 500 mg/Kg (P< 0.01) and 800 mg/Kg (P< 0.001) *Uvariodendron kirkii* respectively.

3.2.2 Effect of *Croton menyharthii* and *Uvariodendron kirkii* aqueous extract after mating

Following the post mating treatment; *Croton menyharthii* at 500 and 800 mg/Kg caused 100% mating success respectively with a non-significant reduction in fertility index at 97% and 90% respectively compared to the negative control (Table 1). *Uvariodendron kirkii* aqueous extract at 500 and 800 mg/Kg caused 100% mating success with a non-significant reduction in fertility index at 96% and 93 % respectively compared to the negative control. *Croton menyharthii* at 500 and 800 mg/Kg caused a significant (P<0.001) prolongation of the gestation length compared to the negative control. *Uvariodendron kirkii* at 500mg/Kg caused a significant (P<0.01) prolongation of the gestation length compared to the negative control (22 ± 1). Both plant extracts caused a non-significant alteration of the litter size compared to the negative control. Both plant extracts caused a significant increase (P<0.05; P<0.01) of body weight (Table 1) compared to the negative control

3.2.3 Effect of *Croton menyharthii* and *Uvariodendron kirkii* aqueous extract before and after mating

*Croton menyharthii* at 500 and 800 mg/Kg caused a significant reduction (P<0.001) in mating success at 20 and 10% respectively. None of the rats had established gestation and none of the rats littered. *Uvariodendron kirkii* aqueous extract at 500 and 800 mg/Kg caused a 100% inhibition of mating and 0% fertility index. Therefore none of the rats got pregnant.

Mating success occurred once a vaginal plug was established or the presence of spermatozoa from a vaginal smear was microscopically observed. Fertility index was calculated as number of non-pregnant
animals divided by total number of animals successfully mated multiplied by 100. In every estrus cycle; a group of follicles are recruited to grow and mature. In this study ovulation occurred and those rats successfully mated. It is possible that fertilization was disrupted as shown by the significant reduction in fertility index. Female fertility is determined by the developmental competence of oocyte; in its ability to be fertilized and give rise to a viable embryo and for that embryo to successfully implant. In the study; Uvariodendron kirkii had the most significant (P<0.001) anti fertility activity (Table 1) compared to the control. Other studies have reported on abortive properties of several medicinal plants. Aerva lantana, Annona reticula (Mitra and Mukhajee, 2009); Alangium salvifoltum (Meena and Rao, 2010); Ananas comosus (Murty and Venkaiah, 2010); Artemisia siverstana wild (Uniyal et al., 2006); Acorus calamus Linn (Gangwar et al., 2010); Adiantum capillus veneris (Benitez et al., 2010).

3.3 Effects of Croton menyharthii and Uvariodendron kirkii aqueous extract on implantation.

Both plant extracts caused a significant anti-implantation activity (Table 1) at all dose levels in the pre mating treatment regime (Table 1). Croton menyharthii at 500 and 800 mg/Kg caused a significant (P<0.01) anti-implantation activity of 58.7% and 48.5 % respectively compared to the control. Uvariodendron kirkii at 500 and 800 mg/Kg caused a significant (P<0.001) anti-implantation activity of 67.1% and 81.3% respectively compared to the control (Figure 2). In the post mating treatment regime; Croton menyharthii at 500 and 800 mg/Kg caused a non-significant anti-implantation activity of 1% and 10 % respectively (Figure 4) compared to the control. Uvariodendron kirkii at 500 and 800 mg/Kg caused a non-significant anti-implantation activity of 2% and 6.2% respectively compared to the control (Figure 4). In the pre and post mating treatment regime; Croton menyharthii at 500 and 800 mg/Kg caused a significant (P<0.01; P<0.001) anti-implantation activity of 68% and 100 % respectively compared to the control (Table 1 and Figure 3). Uvariodendron kirkii at 500 and 800 mg/Kg caused a significant (P<0.001) anti-implantation activity of 100% and 100% respectively compared to the control (Figure 3).

The anti-implantation activity of both plants extracts when administered before mating was significant. This suggests that pre mating extract administration had significant effect on either implantation process or the hormones that control the process. The anti-implantation activity of both plant extracts when administered after mating was not significant (Figure 4). This suggests that post mating extract administration had minimal effect on hypothalamus pituitary gonadal axis which is responsible for Gonadotropin releasing hormone, gonadotropins release and ovarian steroids synthesis. Follicle stimulating hormone and Luteinizig hormone (LH) are key in folliculogenesis, oogenesis and an LH surge responsible for ovulation. Ovarian steroids facilitate endometrium receptivity. Probably after mating, the concentration levels of the extract did not affect the endometrium milieu and had minimal effects on implantation. In the Post mating treatment regime; ovulation and fertilization had already occurred. Probably the ovarian steroids levels were optimal thereby leading to established gestation. When extracts were administered before and after mating; the most significant effect on implantation was observed (Table 1; Figure 3). Probably a pre and post mating extract administration had the most significant effect due to anti-ovulatory and /or anti-implantation properties of both plants. Extract administration through-out the follicular and luteal phase of cycle had the most significant effect on fertility. These results are further supported by (Daniyal
and Akram, 2015, Dinesh et al., 2012) who report on anti-implantation effect of several medicinal plants. Acalypha indica, Ailanthus excelsa, Aristolochia bracteolate, Azadirachta indica, Bambusa vulgaris, Butea monosperma, Citrus medica, Dalbergia saxatilis Linn, Vicia indica, Plumbago zeylanica, Nelumbo nucifera, Hibiscus rosa-sinensis, Heliotropium indicum, Gloriosa superba, Ferula hermonis, Polygonon hydropiper Linn, Ocimum sanctum, Striga orobanchioides, Ricinus communis, punica granatum, Calotropis procera, Mentha arvensis, Lawsonia inermis, Juniperus communis, Hagenia abyssinica and Cicer arietinum. Ethanolic extract of Ricinus communis, fruits of Punica granatum, roots of Calotropis procera, roots of Polygonon hydropiper, leaves of Mentha arvensis, leaves of Lawsonia inermis, seeds of Juniperus communis, roots of Hagenia abyssinica, seeds of Crotalaria juncea, and roots of Cicer arietinum all had strong anti-implantation activity (Maurya et al., 2004).

Conclusion

The disruption of the estrus provides both plants with potential as anti-fertility agents. In order to address the call for novel contraceptive drugs; the anti-fertility efficacy of both plants should be explored further by under taking reproductive hormonal assays, ovarian oogenesis and folliculogenesis studies. A toxicity profile of both plants and phytochemical compounds elucidation should also be carried out. In view of the increasing global population at an alarming rate; novel contraceptive compounds are essential in order to stem un-intended pregnancy incidences.

Acknowledgement

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Research Highlights

Croton menyharthii and Uvariodendron kirkii extracts disrupted the estrus cycle.

Insignificant change in mating success thereby most probably ovulation was not compromised.

Reduction in fertility index was most significant in the pre and post mating treatment regime by both plant extracts. Fertility index reduction no significant change in post mating treatment regime.

Most significant anti implantation effect seen in the pre and post mating treatment regime; followed by pre mating treatment regime. Most probably due to anti ovulatory and anti-implantation properties of both plants.

Research limitations

In adequate access to specialized laboratory equipment; for example to carry out immunohistochemistry and study the gene expressions involved at fertilization and implantation. The effect of both plant extracts on 17β estradiol and progesterone receptors could not be carried out. Yet these steroids moderate the uterine milieu and play a key role in window of implantation.

Research recommendations

Evaluate Effect of both plant extracts on female reproductive hormones.

Evaluate effect of both plant extracts on ovarian and uterine histo-morphology.
Evaluate the effect of both plant extracts on follicle stimulating hormone, luteinizing hormone, 17β estradiol and progesterone receptors using the same three treatment regime as in the study.

Undertake histoimmunochemistry of uterine genes expression during pre and post implantation period.

**What efforts should be undertaken to reduce limitations**

Promote student /research exchange between countries in developed and those in developing countries.

Undertake comprehensive collaborative research between developed and developing world institutions.

Undertake a resource mapping of all African research institutions in the region and establish personnel capacity gaps and strengths; at same time establish specialized equipments in the institutions. Train more scientists in Africa to doctorate and post doctorate levels;

Promote retention of these highly trained researchers by funding their research laboratories.

**Funding and policy (What current policies need to be amended)?**

The Kenya Government should possibly legalize abortion and hence reduce maternal death especially for those that are forced to undergo back street abortion procedures.

Kenyan Government to improve family planning funding and ensure access to correct information and all types of conventional contraceptives in all the health centres across the Country.

Funding and rolling out of reproductive health and sexuality curriculum especially in secondary schools since 50% of unintended pregnancies are in females 15-19 years of age.

**Author’s Contribution**

This study was intellectualized by Catherine Kaluwa Kaingu, Jemimah Achieng, James Mbaria and Stephen Kiama. The investigations were performed by Catherine Kaluwa Kaingu under the supervision of Jemimah Achieng, James Mbaria and Stephen Kiama. Statistical analysis was carried out by Catherine Kaluwa Kaingu and Jemimah Achieng. Original manuscript was written by Catherine Kaluwa Kaingu, reviews and editing were finalized by Catherine Kaluwa Kaingu, Jemimah Achieng, James Mbaria and Stephen Kiama. The final manuscript was read and approved by all authors.

**Authors competing interests**

All authors declare that there is no competing interest.

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