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Valuation of *Synedrella nodiflora* leaves in rabbit feeding as feed supplement: impact on reproductive performance

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Abstract

The current study aims to evaluate the effect of *Synedrellanodiflora* leaves used as feed supplement in the diet of rabbits on their reproductive performances. Then, 96 rabbits (80 primiparous females and 16 males)of Common breed were divided into 4 lots and subjected to different dietary treatments. In lot1, only the female rabbits had received *Synedrellanodiflora* leaves. In lot 2, both males and females were all fed with *Synedrellanodiflora*. In lot 3, only the males were fed *Synedrellanodiflora*, while in lot 4 (control group) neither males nor females were fed with *Synedrellanodiflora*. It appears that the highest litter size (P<0.001) was recorded in lot 1 and lot 2. At weaning, the highest litter size was recorded in lot 2 (P<0.001). The live weight at 25 and 35 days old in kits of lots 3 and lot 4 were higher than those recorded in lots 1 and 2 (P<0.001). The fertility rateof lot 3 was 100% to 80%, 89% and 70% respectively for lot 1, 2 and 4 (P<0.001). The kidding rate was 100% in lots 1, 2 and 4 to 88% in lot 3. Similarly, the highest stillbirth rate was recorded in lot 3 (P<0.001). *Synedrellanodiflora*leaveshad reduced the mortality rate from the birth to the weaning from 14% to 3.4% with the highest rate observed in the control group (P<0.001).Overall, *Synedrellanodiflora* leaves using as feed supplement in rabbits improves fertility rate and litter size, and reduces significantly the mortality rate from birth to weaning.

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Introduction

Rabbit (*Oryctolaguscuniculus*) meat is a delicacy with demand being higher than supply and can be a tool for poverty reduction in Benin as local chickens (Tougan*et al*., 2013). Rabbit meat is very appreciated by consumers for its good nutritional and dietary values (ZotteDalle, 2005). This lean meat type has a high rate of unsaturated fatty acids, low in cholesterol, proteins of high biological value and rich in macro-elements including potassium, phosphorus and magnesium (INRA, 2004; Djago*et al*., 2007). It is a source of ready cash for investment in crop production and purchase of foodstuffs, medicines, school fees and clothing. The manure is also used for soil fertility management.

In Benin, rabbit breeding isan activity of undeniable economic interest which is currently emerging and practiced in all Departments. The statistics of the Association of Rabbit breeders of Benin for the period from1998 to 2007 indicate that the number of rabbits does increased from 2251 in 1998 to 17200 in 2007 with a numerical productivity at weaning varying from 20 to 25 rabbits per female per year (Akpo*et al*., 2008). Increasing this number is intimately related to the control of feeding, health monitoring, rabbit breeding management and reducing mortality of young rabbits (Farougou*et al*., 2005. Kpodékon*et al*., 2006; Akpo*et al*., 2008 ;Koutinhouin*et al*., 2009a, Kpodékon*et al*., 2010). In tropical conditions, rabbit produces an average of 6.4 rabbits per litter (Djago and Kpodékon, 2000; Lebas*et al*., 2004), and the litter size at weaning varies from 4.78 to 4.8 rabbits (Kpodékon*et al*., 2004, Koutinhouin*et al*., 2009b). The fertility rate is 81% in nulliparous women, 61% in primiparous and 50% in multiparous (Koutinhouin*et al*., 2009a). The numerical productivity of rabbits is therefore low in hot and wet climate of Africa. The average weight per rabbit weaned varies between 483 g and 650 g at 35 days of age (Akpo, 2004; Akpo*et al.,* 2008, Kpodékon*et al.,* 2009.). The average daily gain is ranged from 17.95 g to 28 g/d (Kpodekon*et al*., 2009b). The average live weight of rabbits after fattening during a period of 56 days is ranged from 1.92 kg to 2 kg (Djago and Kpodékon 2007; Kpodékon*et al.,* 2009a,b). These reproductive performances are considerably lower than those obtained in the European countries where the reproductive performances of rabbits were improved by hormonal methods (Perrier *et al.,* 2000; Theau-Clement, 2008). This hormonal treatment is to administer to rabbits different types and doses of hormones 2-3 days before the copulation (Koutinhouin*et al.,* 2009b).The relatively high cost of these products, the delicacy of their instructions and packaging requirements do not allow all farmers to use it wisely.

Therefore, it will be very interesting to value the sex hormone plants as *Synedrellanodiflora*in the improvement of the reproductive performance in livestock production.

This plant is described in the literature as having several medicinal properties (Bhogaonkar*et al.,* 2011; Wijaya*et al.,* 2011; Amoateng*et al.,* 2012).

Hidayat (2001a) reported that the leaves of *Synedrellanodiflora* are used in Indonesia as a poultice for sore legs and rheumatism while in Africa the leaves are applied as an embrocation for different oedemas. This author added that an infusion of young leaves is used in Ghana a laxative. In Indonesia, the juice of the leaves is used for the treatment of earache, and in Africa for treatment of mouth affections such as infected gums. In Papua New Guinea, the root is chewed against diarrhoea, together with some other herbs. Dislocated bones are massaged daily with sap from the squeezed leaves. In Fiji, a decoction of the leaves is used to treat haemorrhoids and diarrhoea. A decoction of the pounded and cooked roots is drunk as a cough-mixture in Africa and in Barbados (Szafranski*et al*., 1991; Hidayat, 2001a). In Colombia, the entire plant is used as an emmenagogue. In Indonesia, tender leaves are used in salads (Hussaini*et al.,* 1996; Hidayat, 2001a). Horses, cattle, pigs and rabbits eat the plant readily (Hidayat, 2001a).

In Benin, *Synedrellanodiflora* is available freely on

open waste places, along roadsides and as a common weed and then can be valued in the improvement of reproductive performance in rabbits. According to Hidayat (2001b), *S. nodiflora* contains estradiol, haageanolide and alkane, sterol and triterpenes.

The objective of this study is to evaluate the effect of *Synedrellanodiflora* leaves used as feed supplement in the diet of rabbits of Common breed on their reproductive and growth performances.

Material and methods

Area of study

The study was conducted from March 15 to October 15, 2013 with three rabbit farms in the municipality of Abomey-Calavi of Benin (figure1).Situated at latitude of 6° 27' north and at a longitude of 2° 21' east, the Commune of Abomey-Calavi covers an area of 650 km2 with a population of 307745 inhabitants (INSAE 2010). This area exhibits climatic conditions of sub-equatorial type, characterized by two rainy seasons with an uneven spatial and temporal distribution of rainfall: major (from April to July) and minor (from September to November). These two seasons are separated by a dry season. Average rainfall is close to 1200 mm per year. The monthly average temperatures vary between 27 and 31°C and the relative air humidity fluctuates between 65%, from January to March, and 97%, from June to July.

Vegetal material

The vegetal material used herein is*Synedrellanodiflora;* the genus*Synedrella*is a monotypic genus, belonging to the tribe*Heliantheae,* and taxonomically close to*Wedelia*. *Synedrellanodiflora*is a highly variable, weedy species. *Synedrellanodiflora*(figure 2) is of Asteraceae family, annual plant and an erect branched ephemeral herb usually 30-80 cm tall(Hidayat, 2001a). The shallow root system is usually strongly branched. The erect or ascending, sometimes woody stems, branch dichotomously from the base of the plant; they tend to have long internodes and swollen nodes, to be rounded or slightly angular in section, smooth, often finely hairy, and usually about 50 cm tall. The lower parts of the stems may root at the nodes, especially in damp conditions. The leaves occur in opposite pairs and are 4-9 cm long, elliptic to ovate with three prominent veins and finely toothed margins, finely hairy with short petioles, and joined by a ridge across the stem. The flowers occur in small crowded bunches of 2-8 inflorescences at nodes and tips throughout the upper third of the plant; each inflorescence consists of several erect bracts 3-5 mm long surrounding 5-6 marginal ray florets and 10-20 central disc florets, each 3-4 mm long with a yellow petal. The dark brown to blackish (occasionally paler) seeds are dimorphic. Ray floret seeds are flattened, oblong, 3-5 mm long, with upwardly-pointing teeth along the paler marginal wing. Disc floret seeds are thickened, elongate, 3-4 mm long, with 2-4 stiff bristles at the apex. Both types of seed produce identical individuals, which in turn produce both types of seed (Hidayat, 2001b).

Fig. 1. Area of study.

The seedlings have epigeal germination. The hypocotyl is 8-19 mm long, often purplish, and hairless. The cotyledons are elliptic, 6-8 mm long, often reddish or purplish in colour and shortly stalked. The paired juvenile leaves are similar to the adult leaves but smaller. *S. nodiflora* grows in all disturbed tropical and subtropical habitats where there is sufficient soil moisture for its rapid germination, growth, flowering and seed set. It thrives where there is abundant soil and air moisture (but not soil saturation), grows in a very wide range of

soils (although it is favoured by high organic content and good fertility), and, because of its very short life cycle, can tolerate most forms of cultivation. Whilst able to grow in full sunlight, this species prefers light or broken shade.

Animal management

The current study was carried out on 96 rabbits divided into 4 lots of 24 including 20 primiparous females and 4 males and subjected to different dietary treatments. Animals were reared in cages during the trial. These cages were placed in naturally ventilated buildings and illuminated by daylight. All the animals were fed with a complete commercial pellet feed (2677 DE/kg, 18.8% crude protein) produced by the society "Veto Service Group SA". The amount of pellet feeds distributed was of 200g per day per animal before adding,according to the experimental lot, the feed supplement of *Synedrellanodiflora*leaves.In lot 1, only the female rabbits had received feed supplement made of 100g of fresh *Synedrellanodiflora* leaves. In lot 2, both males and females were all fed with feed supplement made of 100g of fresh *Synedrellanodiflora* leaves. In lot 3, only the males were fed with feed supplement made of 100g of fresh *Synedrellanodiflora* leaves., while in lot 4 (control group) neither males nor females were fed with *Synedrellanodiflora* leaves.This leaves of S. nodiflora were used in the experimental group from the weaning of the first kidding litter to the second kidding. Water was supplied ad libitum.

The mating was carried out by natural insemination by using the reproductive male. The fertility was determined by palpation. After kidding, does and their bunnies were housed together up to weaning.

Health monitoring was based on the use of aseptic foot baths at the entrance of each farm buildings; vitamin and antibiotics drenching was used to prevent disease. Preventive treatment against coccidiosiswas also done. A standard prophylactic endoparasitic and ectoparasitic control schedule was applied. Occasional diseases were treated specifically according to the clinical signs detected.

Data collection

Data collection was done from the individual data record form of each reproductive animal and young rabbit by lot. In total, the study of reproductive parameters was recorded on 80 female rabbits and the weight growth was evaluated from their young rabbits. The number of females in estrus, the number of mated females, the number of pregnant females found after palpation, the number of kidding females, the number of stillborn, the live weight of kits at birth, the live weight of kits at the 25th days old, the live weight of kits at weaning (35th day post-birth) were recorded.

Statistical analysis

The variables included in the data analysis were: litter size at birth and at weaning, the fertility rate, kidding rate, the stillbirth rate, the mortality rate from the birth to the weaning and the weight of kits at 25 days and 35 days post-birth. These data were analyzed using the SAS (Statistical Analysis System, 2006) software. *Proc GLM* procedure was used for variance analysis. The F test was used to evaluate the effect of *Synedrellanodiflora* leaves on the different growth and reproductive parameters considered. Comparisons between means were made in pairs by Student t-test.

Results and discussion

Effect of Synedrellanodiflora leaves used as feed supplement in the diet of rabbits on the litter size and young rabbit growth

The effect of *Synedrellanodiflora* leaves was remarkable (P<0,001) on litter size at birth and at weaning; the live weight of young rabbits at birth, at 25 days and at 35 days post-birth (Table 1). Indeed, the highest litter size were recorded in the lot 1 (8 young rabbits) and lot 2 (7.6 young rabbits), while the lowest values (P<0.001) were recorded in the control group (5.3 young rabbits) and lot 3(5.25 young rabbits). Therefore, *Synedrellanodiflora* leaves improve significantly the litter size in rabbit does, and then can improve profitability of rabbit breeding in sub-Saharan Africa. According to Apori*et al.,* (2014), litter size in rabbits is regarded as one of the most

important economic traits in any breed development and improvement programs for intensive meat production. According to Moce and Santacreu (2010) most maternallines are selected based on litter size at weaning, since this trait reflects both the prolificacy and mothering abilityof the doe.

In the current study, the live weights at birth, at 25 days and at 35 days old of young rabbits from lot 3 and the control group were higher than those recorded at the same age in young rabbit from lots 1 and 2 (P<0,05).

Table 1. Effect of *Synedrellanodiflora* leaves used as feed supplement in the diet of rabbits on the litter size and young rabbit growth.

Variables	*Lot1*		*Lot2*		*Lot3*		*Lot4*		*ANOVA*
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Litter size atbirth	8a	0.4	7.62a	0.32	5.25b	0.25	5.3b	0.42	***
Litter size atweaning	6.13a	0.2	6.25a	0.2	4.4b	0.3	4.57b	0.3	***
Live weightatbirth	49.5a	1.24	48.8a	0.51	51.66b	0.5	52.25b	0.37	*
Live weight at 25 days	259.4a	7.2	282.7b	7.9	306.3c	8.9	310.2c	10.9	***
Live weight at 35 days	389.4 a	18.5	459.9b	13.3	476.1b	21.8	511c	12	***

*SE: Standard Error, ANOVA: Analysis of Variance, *: P<0.05; ***: P<0.001.The means between the classes of the same line followed by different letters differ significantly with the threshold of 5%.*

At weaning, the highest litter size (6.25 rabbits) was recorded in the lot 2 where all the animals were fed with *Synedrellanodiflora* leaves (P<0.001). The live weight recorded at 25 and 35 days old in rabbits of lots 3 and the one of the control group (lot 4) were considerably higher than those recorded at the same age in lots 1 and 2 (P<0.001) where the highest litter sizes were recorde

Table 2. Effect of *Synedrellanodiflora* leaves used as feed supplement on the fertility rate, birth rate, stillbirth rate and birth-weaning mortality rate.

Variables	*Lot1*		*Lot2*		*Lot3*		*Lot4*		*ANOVA*
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Fertility rate (%)	80c	1.08	88.88b	0.95	100a	0	70d	1.78	***
Birth rate (%)	100a	0	100a	0	88.88b	1.03	100a	0	***
Stillbirth rate (%)	4.5a	0.24	5.04a	0.19	7.83b	0.14	5.3a	0.18	***
Birth-weaningmortality rate (%)	5.67a	0.12	3.4b	0.14	9.11c	0.17	14.4d	0.51	***

*SE: Standard Error, ANOVA: Analysis of Variance, ***: P<0.001.The means between the classes of the same line followed by different letters differ significantly with the threshold of 5%*

At birth, the young rabbits from lot 3 where only males were fed using diet supplemented with *Synedrellanodiflora* leaves and the young rabbits of the control group that received exclusively the pellet commercial diet without any vegetal supplement based on *Synedrellanodiflora* weighed respectively 51.7 g and 52 3 g to 48.7 g and 49.5 respectively for rabbits from lot 1 and Lot 2 (P<0.05).

Similarly, at 25 days old, the young rabbits from lot 3(306 g) and those of the control group (310 g) were heavier than rabbits from lot 1 and lot 2, which weighed 260 g and 283 respectively g at 25 days old (P<0.001).At 35 days post-birth, the live weight of

young rabbits from lots 3 and the one of young rabbit from the control lot were significantly higher than that recorded at the same age in lots 1 and 2 (P<0.001). The live weights of the rabbits from the control lot and lot 3 are comparable (ranging from 476 g to 511 g), but higher than that recorded in the rabbits from lot 1 and lot 2, which weighed respectively 389 g and 460 g at 35 days of age (P<0.001, Table 1).

Fig. 2. *Synedrellanodiflora*.

This impact of *Synedrellanodiflora* leaves used as feed supplement for rabbits on the litter size and young rabbit growth could be related to the chemical composition of the leaves of *S. nodiflora*, and more specifically its hormonal content. According to Hidayat (2001b), *S. nodiflora* contains estradiol and haageanolide. Furthermore, leaf contains alkane, sterol and triterpenes. The study of Hidayat (2001b) on the properties of *S. nodiflora* reveals also that upon steam distillation of the leaves, *Synedrellanodiflora* yields a yellow colored essential oil (0.02%), with the terpenes'beta'-caryophyllene, 'beta'-farnesene, germacrene-D and 'beta'-cubebene as major components. From the ethanol extract of the whole plant, the triterpenoidsaponinnodifloside A (oleanolic acid 3-O-'beta'-D-xylopyranosyl-'beta'-D-glucopyranuronosyl methylate) was isolated, together with the triterpenoidoleanic acid-3-O-'beta'-D-glucopyranuronosyl methylate, and the steroids 'beta'-sitosterol, stigmasterol, stigmasterol-3-O-'beta'-D-glycoside and rosasterol.

Synedrellanodiflora also contains a high content of estradiol. Moreover, since 1978,Mannan and Ahmad (1978) have cited *Synedrellanodiflora* in the 4 main sex hormones plants (*SynedrellaNodiflora, Heliotropicumindicum, Belvachal and Phyllanthusneruri*) of Bangladeshi after his preliminary study on sex hormones of medical importance in Bangladeshi plants.

The average total born per litter in the different lots are comparable to those reported by Kpodekon*et al.* (2004), Akpo*et al.* (2008), Koutinhouin*et al.* (2009b), which recorded an average of 5.7 to 6.6 total born ; and total weaned young rabbit ranged from 4.8 to 5.7 per birth in Common rabbits in Benin. However, those performances found herein are lower than those reported by Mahmoud (2008) which recorded an average of 8young rabbits for litter size at birth and 6 young rabbit for litter size at weaning in rabbit ofNéo-Zelandais Blanc, Californien and Géant Blanc breeds reared ina healthier farming system in Canada. This difference could be due not only to the genotype, but can also be linked to the best breeding conditions and climate factors that significantly affect the ability and frequency of females ovulate as was reported Hulot*et al.* (1981) and (Ouyed, 2006).

The variation found in the live weight of the young rabbit at birth, at 25 days old and at 35 days old according the lot in the current study could be due to the difference in the litter size with the low litter size results in high live weight at birth, at 25 days old and at 35 days old. This finding is consistent with the reports of Ouyed*et al.*(2007) who indicate a negative relationship between litter size and growth performance in rabbit. The live weight increases when the litter size decreases. The gradual increase in body weight of young rabbits with age found herein is consistent with the results of Ouyed*et al.* (2010) in rabbitin rabbit of Neo-Zelandais Blanc, Californien and Geant Blanc breeds reared in a healthier farming system in Canada.

Effect of Synedrellanodiflora leaves used as feed supplement in the diet of rabbits on the fertility, birth rate, stillbirth rate and birth-weaning mortality rate

Fertility rates, birth rate, stillbirth rate and birth-weaning mortality rate varied significantly according to the lot (P<0.001; table 2).

The fertility rate of animals of lot 3, where only males were fed leaves with *Synedrellanodiflora* was of 100% to 80%, 89% and 70% respectively for the lots 1, 2 and 4 (P<0.001). The kidding rate of lot 3 where only males were fed with *Synedrellanodiflora* leaves was the lowest (88%) compared to animals of lots 1, 2 and 4 where the kidding rate was 100% (P<0.001). Similarly, the highest stillborn rate (7.83%) was recorded in lot 3 where only males were fed with *Synedrellanodiflora* leaves while the lowest stillbirth rate (4.5 -5.3%) were obtained in animals of lots 1, 2 and 4 (P<0.001). The highest mortality rate recorded from the birth to the weaning (14.4%) was observed in animals of Lot 1 where only the females had received the feed supplement of *Synedrellanodiflora*(P<0.001). This variation of the fertility rate found herein could be related to the sex hormones content of the plant notably the estradiol content (Mannan and Ahmad, 1978; Hidayat, 2001b). According to Mukasa-Mugerwa (1989), prepubertal ovaries also respond when transplanted to mature animals and injecting oestradiol results in LH release in calves as young as 3 months old. The possible causes of sexual maturation at puberty appear to be an increase in pituitary hormones output culminating in increased size and activity of the ovaries and maturation of the hypothalamo-pituitary axis, resulting in secretion of gonadotrophins. Therefore, the highest fertility rate and litter size found in the current study in the rabbit suggested to *Synedrellanodiflora* leaves used as feed supplement in the diet may be related to the hormonal profile of the plant.

Ouyed (2006) found fertility rates of palpation of 92.1% and 93.6% respectively in white New Zealand and Californian rabbits reared in a healthier farming system in Canada. The average stillborn recorded in the current study are significantly lower than those reported for the same rabbit breed in the literature in Benin (Akpo, 2004; Kpodékon*et al.,* 2004;Lebas, 2004; Akpo*et al.,* 2008; Koutinhouin*et al.,* 2009a) in White rabbit of Algeria (Zerrouki*et al.,* 2007).

This difference may be related to the kidding rank because fertility rate at palpation increase with the kidding rank of rabbit does(Ouyed*et al.,* 2007).Inthe current study, we have used primiparousfemales whose maternal instinct might be more developed compared to nulliparous does used by Akpo (2004); Kpodékon*et al.* (2004); Lebas (2004); Akpo*et al.* (2008); and Koutinhouin*et al.* (2009b) .This mortality rate from birth to weaning obtained herein is comparable to that recorded by Fellous*et al.* (2012) in rabbits of the Algerian high experimental station population, but remains lower than 21.5% and 36.61% respectively recorded by Akpo (2004) in the same rabbit breedreared in the same agro-ecological area of Benin. Number range may cause discrepancies between the different results. Mortality rates birth-weaning recorded in the four experimental groups in this study are consistent with the standard (10-15%) indicated by Lebas (2004).Bolet*et al.*(2004) had reported mortality rate from birth to weaning ranging fron 9.5 to 38.5% in rabbits of Argenté de Champagne, INRA 9077, Thuringer, Vienna White, Fauve de Bourgogne, Belgian Hare, Chinchilla, English and Himalayan breeds fed with a commercial diet *ad libitum*.in France.

Conclusion

The study on the effect of *Synedrellanodiflora* leaves used as feed supplement in the diet of rabbits of Common breed on their reproductive and growth performances showed that this plant remarkably affects the litter size at birth and at weaning, the weight of young rabbits at birth, at 25 days and 35 days of age with the highest litter size and lowest live weight found in the group where only females were fed with feed supplementof*Synedrellanodiflora* leave and the group where both males and females were fed with leaves of *Synedrellanodiflora*. *Synedrellanodiflora* leaves had reduced the mortality rate from 14% to 3.4% from the birth to the weaning. Therefore, *Synedrellanodiflora* leaves using as feed supplement in rabbit does not only improve fertility

rate and litter size but also increase significantly the viability of young rabbits from birth to weaning. Since *Synedrellanodiflora*is an available plant known as advent or weed in Benin, the current results will be useful for local rabbit breeders in the improvement of the reproductive performance of rabbits and the profitability of rabbit breeding in sub-saharan Africa. It will be interesting to compare the effect of this sex hormone plant to the one of commercial Pregnant Mare Serum Gonadotrophin (Gonaser®) in further study.

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