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GROWTH PERFORMANCE OF THE HUNTSMAN SPIDER (*SPARIOLENUS ARATTA*) BASED ON DIFFERENT FEED SOURCES

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ABSTRACT

Spiders, though not heavily researched, hold the possible key to new and innovative development, by not only being a source of biological control for farmers aiding in the reduction in the use of pesticides and insecticides on farms. But also, by playing a role in food security. However, in spite of this potential, arachnids (spiders) have not been traditionally included into the formal scientific education as a feed source despite their abundance, familiarity and ease of maintenance in captivity. The objective of this study was to evaluate the effect of selected feed sources on the performance of huntsman spider (*Spariolenus aratta*). The spiders were reared for a period of 14 weeks, with a total of 90 spiders under observation, fed on three feed sources: crickets, black soldier fly and fruit flies. The experimental design was completely randomized block design, replicated 3 times, with 10 spiders per experimental unit. The results were analyzed through the use of R software with least significant test and Pearson correlation test performed in order to determine the significant difference between the types of feed. Analysis for association was undertaken to determine if there was a relationship between the leg span and abdominal length and width during the period of the study (6 weeks). Results showed that spiders fed on crickets had significantly ($P \leq 0.05$) higher growth rate in comparison with those that were fed on black soldier fly larva and fruit flies. Additionally, there was positive association ($r = 1$) between feed in relation to; leg span growth, abdominal length as well as abdominal width during the period of the study. In conclusion based on the three feeds supplied to the spiders', crickets were best in achieving leg and abdominal growth with means; 0.46cm for leg span, 0.34cm for abdominal length and 0.16cm for abdominal width.

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INTRODUCTION

Spiders, though not heavily researched, hold the possible key to the new and innovative development of man, by not only being a source of biological control in the field and in the home (Riechert and Lockley, 1984) but also, by playing a role in food security (van Huis, 2015). Spiders belong to the order Araneae (Kralj-Fišer and Gregorič, 2019), with the huntsman spider belonging to the family Sparassidae. The family Sparassidae comprises of both small to very large spiders, located all around the world (Moradmand, 2013). Huntsman spiders belong to the Sparassidae family and have flattened bodies (Shaw and Seeman., 2011) with laterigrade legs, which when moving gives them a crab like appearance (Rayor, 2018). The laterigrade legs are spread outward as opposed to downward in most spiders, aiding in the speed of the spider (Rayor, 2018).

Huntsman spiders live in various enrionments from; the humid rainforest of the Amazon (Jäger and Kunz, 2005) to the dry arid sand dunes of the Sahara (Rheims, 2010), as well as from sea levels to high attitudes (Moradmand and Jäger, 2012). The huntsman spider is an edible insect; according to the edible insect list compiled by Wageningen university that has a total of 2040 species of edible insects, with the huntsman spider being one of them, eaten in Indonesia and Venezuela (Pinstrup-Andersen, 2009). In areas such as Cambodia, markets feature an edible spider, tarantula (Haplopelma longipes) as food (Münke *et al.*, 2014). Inspite of the aforementioned research findings, information regarding the huntsman spider as a source of feed is limited because little is known of its medicinal properties or it's use as a source of food for humans or feed for livestock (Yen and Ro, 2013).

In comparison to other insects used as feed, four insects are the most studied (Van Huis *et al.*, 2013); black soldier fly, yellow mealworm, common housefly and silkworm, which account for the majority of literature (Van Huis *et al.*, 2013). The dried black soldier fly contains 50 percent of crude protein and 35 percent of lipids on a dry matter basis (Shumo *et al.*, 2019) it is therefore used as an alternative source of protein for; poultry, swine, fish and shrimp (Shumo *et al.*, 2019). The yellow mealworm larva contains 33 percent of fat, 51 percent of crude protein on a dry matter basis (Zhao *et al.*, 2016) and is fed to broiler chickens (Van Huis *et al.*, 2013). The common housefly however has a nutritional profile of between 83.47-94.79 percent of dry matter, 28.63-63.99 percent of crude protein and crude fiber of between 3.14-9.95 percent which is fed to poultry. However, such detailed information regarding the huntsman spider is limited.

Current information surrounding the huntsman spider is focused on its role as a biological agent (Aswathi and Sabu, 2011), its taxonomic classification (Moradmand, 2013), as well as it is sociability with other spiders (Yip *et al.*, 2009). This provides a gap of information on how specifically the spider can be used as a source of food or feed. This research sought to understand the growth rate of the huntsman spider (in terms of abdominal length and leg span) fed on different types of insect-based feed; crickets, black soldier fly larva and fruit flies.

MATERIALS AND METHODS

Study site

The study was conducted in Bondo, Kenya at Jaramogi Oginga Odinga University of Science and Technology laboratory. The spiders were raised in a laboratory environment, coming from egg sacs that were created by spiders captured from the wild.

Experimental design

The experimental design was completely randomized design replicated thrice, giving a total of 90 spiderlings with; ten (10) spiderlings per experimental unit. The treatments were different feed types; crickets, black soldier fly (BSF) larva and fruit flies.

Collection of spiders

The spiders were raised from huntsman spider eggs that hatched in the laboratory.

Housing and data collection

Spiderlings were housed in small plastic cylindrical containers for a period of six (6) weeks. A day prior to hatching, small cylindrical plastic containers were used as housing; the top and sides were perforated with use of a needle. Additionally, bark and stones were placed in the containers to aid as a place to hide as illustrated in the figure 1. Data on leg span, abdominal length and abdominal width was collected in the laboratory. Figure 1("Housing of the spiderlings") illustrates where the spiders were housed during the experiment.

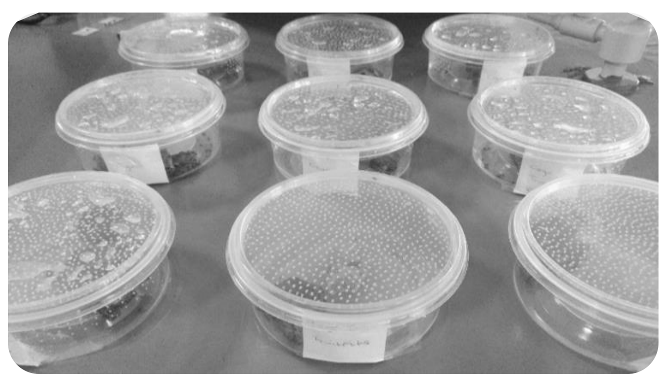

Figure 1. Housing of the spiderlings.

Feeding

The spiders were fed on BSF larva, crickets and fruit flies; the feed was placed at an interval of 4 days, with leg span, abdominal length and abdominal width measured weekly.

Analysis

The data was analyzed using R software with tests; ANOVA, post hoc and correlation test carried out.

RESULTS

The main variable being tested is growth rate of the spiders based on feed being given. In order to test the growth rate; leg span, abdominal length and abdominal width were monitored for a period of six (6) weeks. The experiment consisted of three main sources of feed; House crickets, Black soldier fly (BSF) and the Fruit flies. The experiment was replicated three times, with a total of ten (10) spiders per experimental unit.

Leg span

In terms of leg span; mean was given by μ = 0.4327778, standard deviation σ = 0.08983425 with a mean square error: 0.007541382. Analysis of variance (ANOVA) was taken, from it, it was seen with a p-value of 4.611e-09***, that there is a significant difference in terms of leg span between feeds given. Additionally, a Least significant test (LSD) was carried out to determine where exactly the significance lies. From the test it was noticed, that the difference among the feeds given in terms of leg span growth is crickets, having the highest leg span of 0.46cm. Least significant test (LSD) for leg span was carried out, table 1 illustrates the feed given with a confidence interval of 95% in relation to leg span of the spiderlings. Additionally, the critical value of t is given by 1.964391, with a minimum significant difference of 0.01798176.

Table 1. LSD test of leg. Span.

	Leg. Span	Standard (std)	Correlation coefficient (r)	Lower control limit (LCL)	Upper control limit (UCL)	Min	Max
BSF	0.4216667	0.06708204	180	0.4089516	0.4343817	0.3	0.6
CRICKETS	0.4655556	0.09473410	180	0.4528405	0.4782706	0.3	0.8
FRUITFLIES	0.4111111	0.09565352	180	0.3983961	0.4238261	0.3	0.7

Table 2 represents the treatments in relation to leg span; where, the groups with the same letter are not significantly different from each other. From the table it can be seen that feeds; BSF and Fruit flies are not significantly different from the other in terms of leg span growth of the spiderlings; whereas Crickets are significantly different in terms of leg span in comparison with BSF and Fruit flies. An illustration of the leg span growth is shown in figure 2. Figure 2 ("Box plot of feed per week in relation to leg span growth") highlights the growth of the spiderlings based on the different feeds given per week.

With the overall mean and standard deviation represented as; Crickets, μ= 0.46, σ= 0.09 and n=180; BSF, μ= 0.42, σ= 0.06 and n=180; Fruit Flies, μ= 0.41, σ= 0.09 and n=180.

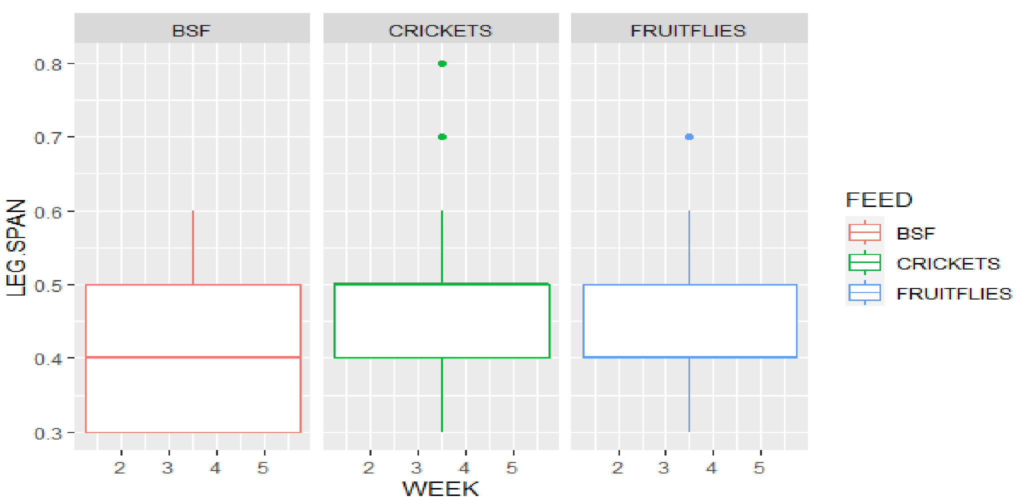

Figure 2. Box plot of feed per week in relation to leg span growth.

Table 2. Significant differences between the groups of feed in terms in leg. Span.

	Leg. Span	Groups
CRICKETS	0.4655556	a
BSF	0.4216667	b
FRUITFLIES	0.4111111	b

Abdominal length

In terms of abdominal length, mean was given by μ = 0.2987037, standard deviation σ = 0.08624395 with a mean square error = 0.006552762. Analysis of variance (ANOVA) was taken, from it, it was seen with a p-value of 6.168e-16***, that there is a significant difference in terms of abdominal length between feeds given. Additionally, a least significant test (LSD) for abdominal length was carried out, table 3 below illustrates the feed, mean and individual (95%) confidence interval (CI) in relation to leg span of the spiderlings.

The Table 3, illustrates the feed given with a confidence interval of 95% in relation to abdominal length of the spiderlings. The critical value of t is given by 1.964391, with the minimum significant difference being 0.01676174.

Table 4 represents the treatments in relation to abdominal length; where, the groups with the same letter are not significantly different from each other. From table 4, the feeds that are significant and those that are not significant from each other.

From the given Table 4 it can be seen that feeds such as BSF and Fruit flies are not significantly different from the other in terms of abdominal length growth of the spiderlings; whereas spiderlings fed on Crickets had significant growth in terms of abdominal length in comparison with BSF and Fruit flies. An illustration of the abdominal length growth is shown in figure 3. Figure 3 ("abdominal length of spiderlings given different types of feed") highlights the growth of the spiderlings based on the different feeds given. In terms of abdominal length, the overall mean and standard deviation is represented as; Crickets, μ= 0.34, σ= 0.09 and n=180; BSF, μ= 0.27, σ= 0.06 and n=180; Fruit Flies, μ= 0.28, σ= 0.08 and n=180.

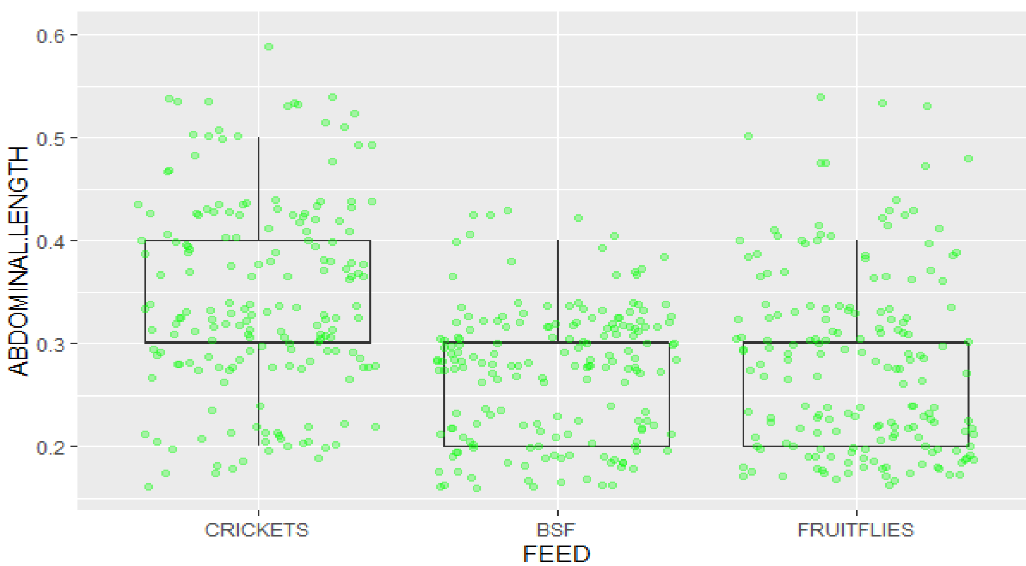

Figure 3. Abdominal length of spiderlings given different types of feed.

Table 3. LSD test of abdominal. Length.

	Abdominal. Length	Standard (std)	Correlation coefficient (r)	Lower control limit (LCL)	Upper control limit (UCL)	Min	Max
BSF	0.2738889	0.06013383	180	0.2620366	0.2857412	0.2	0.4
CRICKETS	0.3411111	0.09141280	180	0.3292588	0.3529634	0.2	0.6
FRUITFLIES	0.2811111	0.08766932	180	0.2692588	0.2929634	0.2	0.5

Table 4. Significant differences between the groups of feed in terms in abdominal. Length.

	Abdominal. Length	Groups
CRICKETS	0.3411111	a
BSF	0.2811111	b
FRUITFLIES	0.2738889	b

Table 5. LSD test of abdominal. Width.

	Abdominal. width	Standard (std)	Correlation coefficient (r)	Lower control limit (LCL)	Upper control limit (UCL)	Min	Max
BSF	0.1222222	0.04168994	180	0.1145613	0.1298831	0.1	0.2
CRICKETS	0.1650000	0.06023696	180	0.1573391	0.1726609	0.1	0.3
FRUITFLIES	0.1316667	0.05335137	180	0.1240058	0.1393276	0.1	0.3

Table 6. Significant differences between the groups of feed in terms in abdominal width.

	Abdominal. width	Groups
CRICKETS	0.1650000	a
BSF	0.1316667	b
FRUITFLIES	0.1222222	b

Abdominal width

In terms of abdominal width, mean was given by $\mu = 0.1396296$, standard deviation $\sigma = 0.05536061$ with a mean square error = 0.002737637. Analysis of variance (ANOVA) was taken, from it, it was seen with a p-value of 2.53e-14***, that there is a significant difference in terms of abdominal width between feeds given. Additionally, a least significant test (LSD) for abdominal width was carried out, table 5 illustrates the feed given with a confidence interval of 95% in relation to abdominal width of the spiderlings. Additionally, the critical value of t is given by 1.964391, with a minimum significant difference of 0.01083415.

Table 6, represents the treatments in relation to abdominal width; where, the groups with the same letter are not significantly different from each other. From the table it can be seen that feeds; BSF and Fruit flies are not significantly different from the other in terms of abdominal width; while Crickets are significantly different in terms of abdominal width in comparison with BSF and Fruit flies.

Correlation

An additional test was carried out, that is Pearson's correlation (r); in order to measure the strength of the association between the variables being measured. Given the three variables, the following groups were used in order to determine association; firstly, was the association between leg span and abdominal length (group 1), secondly was the association between leg span and abdominal width (group 2), lastly was the association between abdominal length and abdominal width (group 3). A correlation test was carried out using R software, group 1 had a r value of 0.759 (r = 0.759) which is represented using figure 4. Figure 4 ("Association between leg span and abdominal length") illustrates relationship between abdominal length and leg span of the spiders throughout the period of the study.

From figure 4, it is noted that the r value 0.76 is closer to 1 than -1 and given the direction of the slope. It is seen that there is a positive association between the variables leg span and abdominal length. Indicating that both variables increase together, therefore, in terms of growth of the spiders in this experiment, as leg span increased, abdominal length also increased.

In group 2, r = 0.596, which indicates a positive relationship between leg span and abdominal width of growth of the spider it is represented in figure 5. Figure 5 ("Association between leg span and abdominal width") illustrates the association between abdominal width and leg span of the spiders during the period of the study.

Lastly, association between variables in group 3 were calculated, illustrated in figure 6. Figure 6 ("Association between abdominal width and abdominal length") illustrated the association between abdominal width and abdominal length, giving r = 0.756, showing a positive association between the variables. Hence, they increase together, as abdominal width increases so does abdominal length.

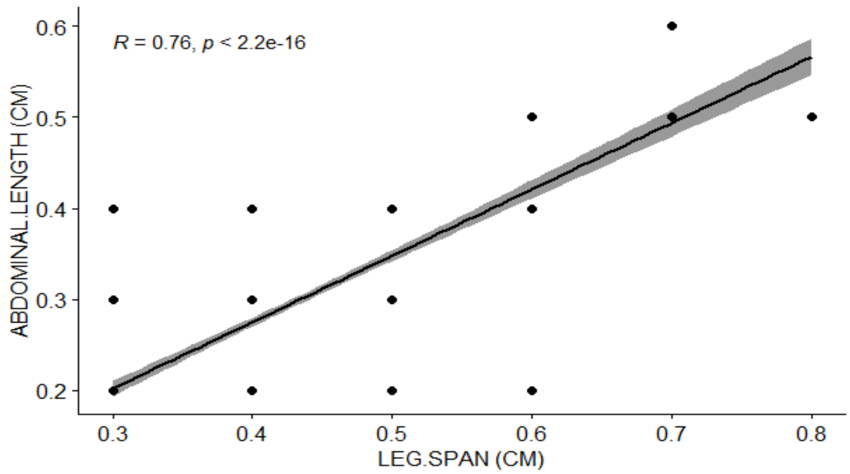

Figure 4. Association between leg span and abdominal length.

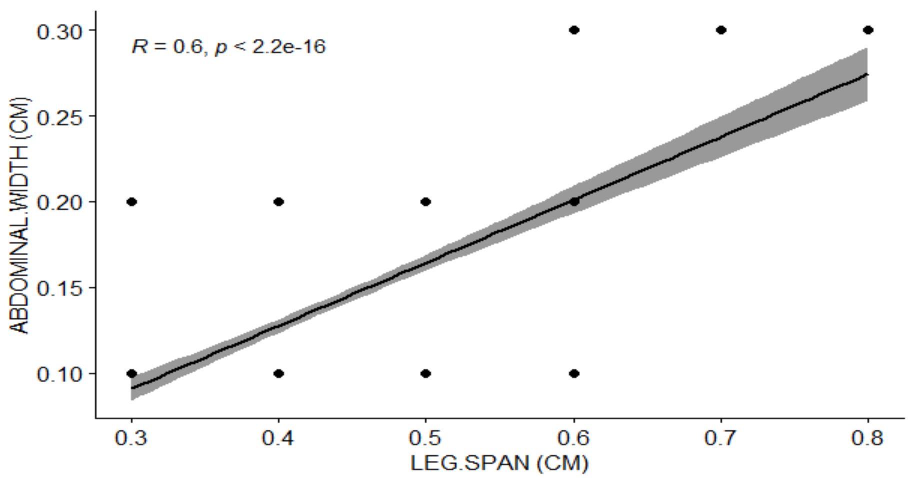

Figure 5. Association between leg span and abdominal width.

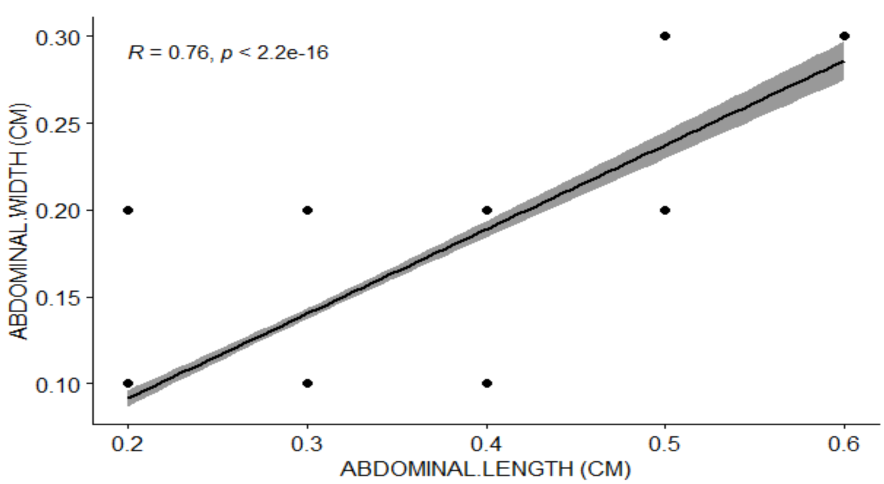

Figure 6. Association between abdominal width and abdominal length.

DISCUSSION

The spiderlings performance was evaluated based on three types of live feed; crickets, BSF larva and fruit flies. Because the spiders only feed on live insects, serving of fruit flies was made possible by freezing. The spiderlings live on live prey, as opposed to spider species *H. graminicola*. Because of *H. graminicola* small size, handling of live prey is undoubtedly difficult, hence it is reared on dead prey (Peng *et al.*, 2013). It should be noted that the size of the feed given should not be bigger than the size of the spider, specifically for the spiderlings as they slowly adapt to the different prey. Highlighted by (Peng *et al.*, 2013), as results of their study proved the need for species and size specific selection of prey for rearing spiders. Once grown however, they are able to catch prey bigger than their size, supported also by (Rayor, 2018) who puts emphasis on size of the prey depending upon the size of the spiderlings. As seen from the results; leg span was highest in BSF larva and Crickets as opposed to Fruit flies in a period of six (6) weeks. Abdominal length is highest in Crickets as opposed to BSF larva and fruit flies. Then finally, abdominal width is highest in Crickets and BSF larva and lowest in Fruit flies. Therefore, overall, the spiderlings responded best to Crickets followed by BSF larva and finally Fruit flies in relation to growth over a period of six (6) weeks. Which agrees with (Röös *et al.*, 2017), who pointed out that there is a linear growth in carapace width among spiders of different instars.

CONCLUSION AND RECOMMENDATIONS

The dynamics of sustainable agriculture is noticed in relation to biological control, given the food intake of spiders (being insects). From the study, it was noticed that the growth performance of spiderlings was best when fed on crickets followed by BSF larva and lastly Fruit flies. Showing its potential to act as a biological control agent and easily attack pests that are targeting field crops. Given that huntsman spiders eat insects as opposed to organic material (plants in field). Therefore, reducing the number of pests in the field as well as further reducing on the use of insecticides and pesticides by farmers. Reducing on chemical application costs and promoting of organic agriculture. I recommend, further studies on spider rearing facilities that can be applicable not only at small scale but large scale as well and more studies on formulation of spider feed supplement. I further encourage extension agents to promote the use of spiders on farms to not only act as a source of biological control through rearing of the spiders alongside field crops. But also, to act as a possible feed source of livestock.

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