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Comparison of body mass, feeding and food conversion of temperature acclimatized Porcellionides pruinosus (Brandt, 1833) (Isopoda, Oniscidea) fed on the dry leaf of Punica granatum

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مقارنة كتلة الجسم وكيفية التغذية والتحول الغذائى عند الأقلمة الحرارية لقملـــــــــة *Porcellionides pruinosus* (متشابهة الاقدام، قمليات الخشب) (Brandt, 1833) المغذاة بأوراق جافة من نبات الرمان *Punica granatum*

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لقد تمت دراسة مفصلة لعديد من العوامل منها كتلة الجسم , المحتوى المائي , كفاءة التمثيل الغذائي , كفاءة النمو والزيادة الكلية وكذلك معدلات الأيض الغذائي لقمل الخشب *بورسيليونيدس برونوسس* والتي تمت أقلمتها عند مستويين من درجات الحرارة هما 14 د.م و21 د.م ولمدة خمسة عشر يوماً تغذى فيها قمل الخشب على الأوراق الجافة لنبات الرمان. وقد تم وصف التركيب الكيميائي لأوراق النبات المذكور وكذلك التربة المصاحبة .

أثبتت النتائج عدم وجود زيادة ملموسة في وزن الجسم لقمل الخشب المأقلم عند 21 د.م (0.6 مليجرام) مقارنة بمثيلة عند 14 د.م بالرغم من وجود إختلافات ملموسة للعوامل الأخرى مثل المحتوى المائي ($t=2.3; P<0.01$) , كفاءة التمثيل الغذائي ($t=10.2$; $P<0.01$) ومعدلات التغذية ($t=10.2$; $P<0.01$) عند كلاً من درجتي الحرارة المذكورتين.

وقد وجد أيضاً علاقة عكسية مميزة بين معدلات الإبتلاع في قمل الخشب وكفائة الإمتصاص فقد وجد ان 10.7 % من الطعام الممثل غذائياً عند درجة الحرارة 14 وكذلك 14.4 % عند الدرجة 21 قد استخدما في تكوين انسجة جديدة. بالإضافة لذلك وجد ايضاً ان معدل استهلاك الطعام لهذه الكائنات عند درجتي الحرارة 14 و21 كان على التوالي 2.57 % و 3.21 % من كتلة الجسم وبصفة يومية.

KEY WORDS: *ASSIMILATION AND CONVERSION, BODY MASS, FEEDING, PORCELLIONIDES PRUINOSUS. PUNICA GRANATUM, TEMPERATURE ACCLIMATIZATION, WOODLOUSE.*

ABSTRACT

A detailed study was conducted on the body mass; moisture; assimilation efficiency; gross and net production efficiencies; feeding, assimilation; conversion and metabolic rates of the woodlouse *Porcellionides pruinosus* acclimatized at 14°C or 21°C for 15 days and fed on the dry leaf of *Punica granatum* (pomegranate). Brief descriptions are given on the chemical composition of *P. granatum* leaf and on the analyses of soil of the habitat of *P. pruinosus*. A marginal insignificant increase of 0.6 mg body mass was observed in this woodlouse acclimatized at 21°C when compared with the value recorded at 14°C. However, significant differences existed on moisture ($t = 2.3$; $p<0.01$), assimilation efficiency ($t = 10.2$; $p<0.01$) and feeding rate ($t = 10.2$; $p<0.01$) between the temperature acclimatized woodlice. An inverse relationship was discernible in this woodlouse between rate of ingestion and efficiency of absorption. Only 10.7% assimilated food at 14°C and 14.4% at 21°C were converted into the production of new tissues. The food consumption of *P. pruinosus* at 14 and 21°C were 2.57% and 3.21% body mass/day respectively.

Introduction

Porcellionides pruinosus (Brandt, 1833) is the common woodlouse found in Benghazi (32° 10'N, 20° 06'E) and its neighborhood in Libya. This species is cosmopolitan of Mediterranean in origin and is widespread in Jordan [1] and in Arabian peninsula [2]. It co-exists with another woodlouse *Porcellio scaber* in farms and with the pillbug *Armadillo officinalis* in woodlands of Benghazi and plays an important role in the litter breakdown and enrichment of soil fertility. Except for the biometry studies [3,4], nothing further is known about them from Benghazi. The present study investigated the effects of temperature acclimatization (14 or 21°C) on the body mass, feeding and food conversion of *P. pruinosus* fed on the dry leaf of *Punica granatum* (Pomegranate). Pomegranate trees are common in farms of Benghazi and these woodlice form a major component of the decomposer fauna of the fallen litters from these trees. The reason for selecting 14 and 21°C as acclimatization temperatures was based on our field observations, where *P. pruinosus* was found active when the temperatures ranged between 12°C at the bottom and 23°C at the top strata of the fallen litters of Pomegranate.

Material and Methods

Sub-adult *P. pruinosus* weighing 35 to 40 mg were selected for the study. Ten woodlice (5 males and 5 females), after starving them for 24 hours to evacuate their gut contents, were maintained at 14 or 21°C in a Gallenkamp incubator. Each animal, after taking its initial body mass near to 0.01 mg in a Sartorius balance, was kept in a glass petridish (5 cm diameter, 2.5 cm height) containing a layer of wet filter paper (65 ± 2% R.H) at the bottom + a small quantity of the sieved soil of the habitat of these woodlice. 200 mg of the dry leaf of *P. granatum* macerated with water for 12 hours to make it soft was provided as food. The experiment lasted for 15 days, after which the body mass of the animal was determined. The remaining leaf and the fecal matter ejected by the woodlouse were collected, dried and weighed. The animals were kept at 60°C for four days, dried and weighed to determine the moisture content. The experiment was repeated again and there were not many variations in the values between the replications, so the data were combined and the mean values of 20 woodlice at each temperature were taken.

Food consumption (C) of *P. pruinosus* kept at 14 or 21°C was estimated in terms of mg dry food consumed by it for 15 days. Assimilation (A) was calculated by subtracting the amount of dry fecal matter (Fe) ejected from the total food consumed (C). The production rate (P) (due entirely to the increase in live mass) was determined as the difference between the body mass of the animal at the beginning and at the end of the experimental period.

Metabolism (M) represented the difference between A and P. Assimilation efficiency (Ae) was calculated by expressing A as a percentage of C. Gross (Gc) and net (Ne) production efficiencies were estimated expressing P as a percentage of C and A separately. Rates of feeding (Fr), assimilation (Ar), conversion (Cr) and metabolism (Mr) were determined by dividing C, A, P and M by half the sum of initial and final weights of the animal and by the duration of exposure period and expressed in terms of mg/g live wt/day.

t-tests[5] were done to find out the significance or otherwise of the data.

Results and discussion

P. granatum leaf has betulic acid; ursolic acid; corelagin; strictinin; tannin; granatin; casuarin; D-Mannitol; 2-0-galloylpunicalin; 2-(2-propenyl)-delta-piperideine; 1,2,3,4,6 – penta-0-galloyl-beta-D-glucose; riboflavin; protein [6]. Our observations in the field revealed that the leaf of *P. granatum* is a preferred food for *P. pruinosus* which was later confirmed through laboratory studies on the food preferences shown by them.

The soil of the pomegranate farm (habitat of *P. pruinosus*) was light loam (29% clay, 35% silt, 36% sand), pH averaged 7.1 and organic matter 6.2%. The soil contained 0.6% nitrogen, 164 ppm phosphorus and 46 ppm potassium. The ions ranged from 1 meq/L nitrate to 90 meq/L chloride (the concentrations of other ions were: bicarbonate: 17 meq/L, magnesium: 33 meq/L, calcium: 35 meq/L, sulphate: 40 meq/L and sodium: 70 meq/L).

Table 1 shows the increment in body mass; moisture; assimilation efficiency; gross and net production efficiencies; feeding, assimilation, conversion and metabolic rates of *P. pruinosus* at 14 or 21°C, their t-values and levels of significance.

Table 1. Body weight gain, feeding and food conversion parameters (Mean ± SE) of *P. pruinosus* acclimatized at 14 or 21°C for 15 days and fed on the dry leaf of *P. granatum*.

Parameters	Animals exposed to the temperatures of 14°C	21°C	t	P
Body weight gain (mg)	3.0 ± 0.6	3.6 ± 1.2	0.43	>0.05
Moisture (%)	78.8 ± 2.9	74.5 ± 2.3	3.31	<0.01
Assimilation efficiency (%)	68.6 ± 2.0	59.7 ± 3.7	2.31	<0.05
Gross production efficiency (%)	7.8 ± 1.4	8.0 ± 2.3	0.10	>0.05
Net production efficiency (%)	11.8 ± 2.2	13.1 ± 3.4	0.31	>0.05
Feeding rate (mg/g live wt/day)	68.6 ± 2.0	85.7 ± 2.1	10.23	<0.01
Assimilation rate (mg/g live wt/day)	47.5 ± 7.3	51.1 ± 9.0	0.32	>0.05
Conversion rate (mg/g live wt/day)	5.1 ± 1.1	7.4 ± 1.9	1.11	>0.05
Metabolic rate (mg/g live wt/day)	42.2 ± 5.5	43.8 ± 8.2	0.56	>0.05

There was an increase of 3 mg (7.5%) in body mass of *P. pruinosus* at 14°C, and 3.6 mg (10.3%) in those at 21°C, even though the difference in increment in body mass was insignificant ($t = 0.43$; $p>0.05$). The percentage of moisture in this woodlouse at 14°C was 78.8% which decreased significantly ($t = 3.31$; $p<0.01$) to 74.5% in those maintained at 21°C. Also, significantly higher assimilation efficiency ($t = 2.31$; $p<0.05$) was recorded in those

acclimatized at 14°C (68.6%) than those at 21°C (59.7%). The assimilation efficiencies of *P. pruinosus* recorded in the present study were lower than those recorded for *Porcellio scaber* acclimatized at 14°C (82.1%) and 21°C (78.5%) and fed on *P. granatum* leaf [7]. However they were higher than the ones tabulated for the desert isopod *Hemilepistus reaumuri* (51.2%) [8] and the pillbug *Armadillo officinalis* (44.9%) [9] fed on the leaf litters of their habitats under natural conditions. It was reported earlier [10, 11] that the assimilation efficiency of woodlice increased with the concentration of copper ions in the food causing an increase in weights of many woodlice. This interesting observation needs to be studied in detail in the woodlice of Benghazi.

There were increasing trends in gross (3.2% increase) and in net (10.4% increase) production efficiencies in *P. pruinosus* from the lower (14°C) to the higher (21°C) temperatures, even though the difference in values between temperature acclimatized woodlice was insignificant ($t = 0.10$ for gross; $t = 0.31$ for net production efficiencies; $p>0.05$).

Higher values of feeding, assimilation, conversion and metabolic rates were observed in *P. pruinosus* kept at 21°C when compared with the values recorded at 14°C. However, a significant difference ($t = 10.23$; $p<0.01$) was discernible only on their feeding rates. The difference in assimilation rate, in *P. pruinosus* between the acclimatized temperatures was only 7.7% and only a small percentage of the assimilated food was converted for the production of new tissues (10.7% at 14°C and 14.4% at 21°C) and the remaining were utilized for their metabolic activities. Apart from it, the energy lost through respiration by terrestrial isopods also should be taken into account which is in the order of 150 J (g live wt)/day, with an approximate range of 75 to 300 Jgd [12].

The food consumption of *P. pruinosus* fed on *P. granatum* was 2.57% body mass/day at 14°C, and 3.21% body mass/day at 21°C. These were lower than the values recorded for *Porcellio scaber* fed on the same leaf material at the same acclimatized temperatures (2.59% at 14°C, 4.19% at 21°C). However, the values recorded in the present study were higher than those reported for *P. scaber* fed on the dry leaf of *Citrus aurantium* (1.2 to 1.4%) and *Eucalyptus rudris* (2.5% to 2.7%) [13]. An inverse relationship between rate of ingestion and efficiency of absorption of food has been reported for certain terrestrial isopods [8,9,10,13,14,15,16]. Similar relationship was observed in the present study also. Such a relationship can help to equalize the rates at which nutrients are absorbed and it seems to hold well only if the same type of food passes through the gut at different speeds [15]. Further studies on the thermal impacts on the speed of the passage of different diets through the gut can throw light on the rates of absorption of nutrients by this woodlouse. Also its contribution to litter breakdown along with *A. officinalis, H. reaumuri* [17] and *Porcellio scaber* in the wild will give an idea on the roles played by woodlice in general on the decomposition of leaf litter in Benghazi farms.

In conclusion, temperature acclimatization at 14 or 21°C has a significant impact on the moisture, feeding rate and assimilation efficiency of *P. pruinosus*, but not so on their increment in body mass, gross and net production efficiencies; assimilation, conversion and metabolic rates. The effects of temperature on the activity of this woodlouse was confirmed in the field where *P. pruinosus* were found actively moving and feeding the fallen litter when the surface temperature ranged between 13 to 26°C, even though activities were restricted to shady places.

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