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Comparative honey production and hoarding capacity of two caged native honey bee subspecies

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Summary : The study aims the comparison of the hoarding and production capacities of two local honey bee subspecies ; *Apis mellifera intermissa* (AMI) and *Apis mellifera saharensis* (AMS). The experiment was carried out in laboratory between april-may 2021. One capped brood frame of each breed was incubated at 34-35°C and at 70% RH. Emerging bee workers were transferred within 24 hours in a cage endowed with two gravity feeders of sucrose solution (50% w/w), water, pollen paste and a piece of comb of known dimension and weight. Cages were maintained in 35°C at 50% of air relative humidity. Consumption of sucrose solution was recorded daily and the final honey storage was estimated by gravimetric analysis. Results indicate that the onset of honey deposition in the wax cells started after 10 and 16 days for AMI and AMS respectively. AMS consumed more syrup than AMI with 32.12±3.34ml against 28.44±2.35ml. During a period of 14 days, AMS stored 16.20±1.88g of honey, averaging 22 mg/bee/day. Whereas AMI stored during a period of 20 days, 14.27±1.44g of honey, with an average of 14.2 mg/bee/day. Moreover, results suggest that under laboratory conditions ; the production of honey was similar ($F<0.231$) for both subspecies, whereas the hoarding capacity was more important for AMI than AMS ($F<0.491$). Remarkably, AMS showed ($F< 0.001$) in every replication ; a consistent delay in the onset of honey production but ended eventually in yielding the same honey quantity as AMI.

Mots clés : *Algeria, hoarding, honey, Apis mellifera intermissa, Apis mellifera saharensis*

ملخص

تهدف الدراسة إلى مقارنة المخزون والقدرة الإنتاجية لنوعين محليين من نحل العسل. *Apis mellifera intermissa* (AMI) *Apis mellifera sahariensis* (AMS) أجريت التجربة في المختبر بين شهري أبريل–مايو 2021. تم تحضين إطار الحضنة المغطاة لكل سلالة عند 34–35 درجة مئوية وعند

70% الرطوبة النسبية. تم نقل العاملات ناشئات خلال 24 ساعة في أقفاص مزودة بمغذيتين بجاذبية، لمحلول السكروز (70% w/w)، ماء، معجون حبوب اللقاح وقطعة مشط ذات أبعاد ووزن معروفين. تم الحفاظ على الأقفاص في حاضنةعند 35 درجة مئوية عند 50% الرطوبة النسبية. تم تسجيل استهلاك محلول السكروز يومياً وتم تقدير سعة تخزين العسل النهائية عن طريق التحليل الوزني. تشير النتائج إلى أن بداية ترسب العسل في خلايا الشمع بدأت بعد 10 و16 يومًا لـ AMI و AMS على التوالي. استهلك AMS شرابًا أكثر من AMI مع 32.12 ± 3.34 مل، مقابل 28.44 ± 2.35 مل. خلال فترة 14 يومًا، خزنت AMS 16.20 ± 1.88 g من العسل، بمتوسط 22 مغم / نحلة / يوم. بينما تم تخزين AMI خلال فترة 20 يومًا، 14.27 ± 1.44 g من العسل، بمتوسط 14.2 مغم / نحلة / يوم. تشير النتائج إلى أنه في ظل ظروف المختبر؛ كان إنتاج العسل مشابهًا (F< 0.231) لكلا النوعين الفرعيين، في حين كانت سعة التخزين أكثر أهمية بالنسبة لـ AMI من AMS (F< 0.491. بشكل ملحوظ، أظهر مقياس الدعم الكلي (F< 0.001) في كل تكرار؛ تأخرًا ثابتًا في بداية إنتاج العسل ولكنه افي النهاية أدىإلى إنتاج نفس كمية العسل مثل AMI.

الكلمات الدالة **:** *الجزائر، مخزون، عسل، Apis mellifera intermissa، Apis mellifera sahariensis*

INTRODUCTION

The most common Western honey bees (*Apis mellifera* L.) subspecies present in Algeria are *Apis mellifera intermissa* (Buttel-Reepen, 1906) (fig. 1) known as ‘‘Tellian bee’’ and *Apis mellifera sahariensis* (fig. 2) (Baldensperger, 1924) known as ‘‘Saharan bee’’. Most of the apiaries are essentially composed of Tellian bees despite being reputed aggressive (Le Conte and Navajas, 2008) ; prone to swarming and abundant use of propolis (Ruttner, 2013). In contrast, Saharan bee is known as moderately incline to swarming, a weak defensive behaviour and little propolis use (Haccour, 1960; Ruttner, 2013). Both subspecies have been a subject of several morphometric, behavioral, physiological and genetic studies (Haddad et *al.,* 2015 ; Adjlane and Haddad, 2014, Barour and *al.,* 2011; Ritter, 1990 ; Kefuss, 1995 ; Gadbin et *al.,* 1979 and Clément et *al.,* 2002). However, due to the difficulties to evaluate colonies’performance during the natural nectar flow ; no study, to our knowledge, has documented hoarding behavior and honey productivity of both subspecies. Therefore, this study aims to fill the knowledge gap and attempt to document if the two genotypes originating from different climates show contrasted behavior. Besides, the results will confirm or depart from the general beekeepers’ ‘‘perception’’ that considers AMS less productive.

Figure 1 : *Apis mellifera intermissa* (original).

Figure 2 : *Apis mellifera sahariensis* (original).

MATERIALS AND METHODS

The experiment was carried out during April-May 2021 at the Apidology Laboratory of Animal Production Research Division of the National Institute of Agricultural Research of Algeria (INRAA). Bees of both subspecies were obtained from INRAA's apiaries. One frame of capped workers brood for each breed was removed from apiary and put in dedicated boxes and incubated in the dark at 34-35°C and at 70% of air relative humidity (fig. 3).

Within 24hours after emergence, worker bees were progressively confined in wooden hoarding cages ; 50 bees/cage and 3 cages/subspecies were used. In order to maintain the same worker bees populationduring the whole experiment period; two additional identical cages per subspecies were planed under the same

Figure 3 : Worker bees cappedbroodframe in sealed box under controlled light, temperature and humidity (original).

treatment than main cages. The hoarding cages (Pain, 1966) consisted of 12 × 10 × 4 cm mini-hives (fig. 4) endowed with transparent and removable sides and ventilation holes. A piece of builded comb of known weight was added (fig. 5) as well as two 14 ml graduated centrifuge coned-ends plastic tubes as feeders to provide water and sucrose solution (50% w/w). All cages were placed in standard conditions (incubator at 34-35°C and 65-70% relative humidity for 14 days) and kept in the dark to simulate hive conditions (fig. 6).

The period of the experiment was over 30 days, during which we recorded the daily sucrose solution, dead bees were discarded and replaced by other bees of the same age. The wax cells were checked using a torch to check the start of honey deposit.

After 30 days, the pieces of builded comb bonded inside the cages were removed and weighed (fig. 7). Total honey production for each subspecies was estimated by subtracting the initial from the final weight. Mortality was recorded daily.

The hoarding behavior of colonies was estimated by recording sucrose solution consumed from thefeeding container per bee per day (ml/day/bee)

RESULTS AND DISCUSSION

Overall, results suggest that *Apis mellifera sahariensis* (AMS) stored 16.20±1.88g of honey less than *Apis mellifera intermissa* (AMI) with 14.27±1.44g (fig. 8). In term of sucrose solution consumption ; AMS consumed in average 32.12±3.34 ml of sucrose

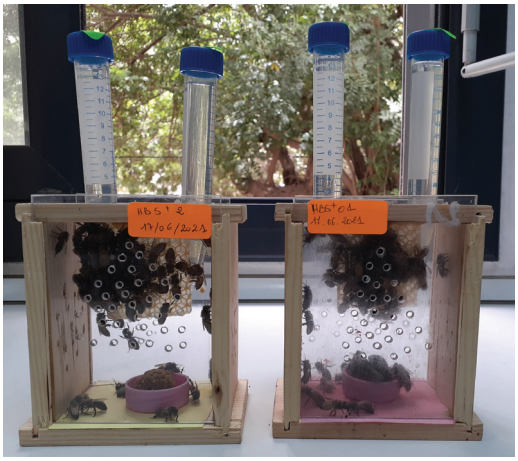

Figure 4 : Hoarding cages modified from (Pain. J, 1966) (original).

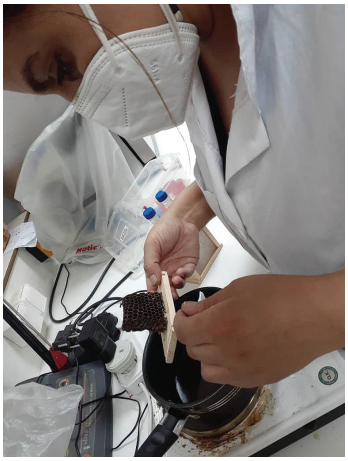

Figure 5 : Piece of builded comb of a known initial weight bonded inside the hoarding cage (original).

Figure 6 : Incubation conditions and environment of the emerging worker bees (original).

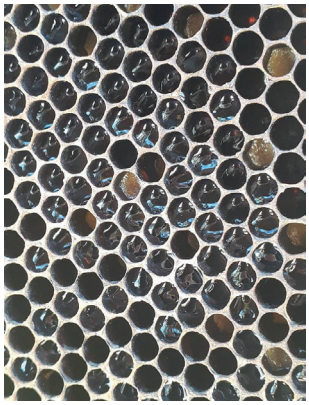

Figure 7 : Monitoring of the honey production onset using a torch (original).

solution whereas AMI consumed 28.44±2.35 ml (fig. 9). As for onset of honey production, AMI started in average at age 10.3 ±0.6 day and AMS later at day 16±1.

After 30 days of experimentation; AMI stored less than AMS but the difference is not significant (F<0.231), therefore the hypothesis that genotype may induce difference in honey productivity is not confirmed in this study. Moreover, the results seem to hint that AMS did produce at least at the same level than AMS contrary at prevailing beekeepers' perception which is an interesting finding if confirmed in subsequent studies.

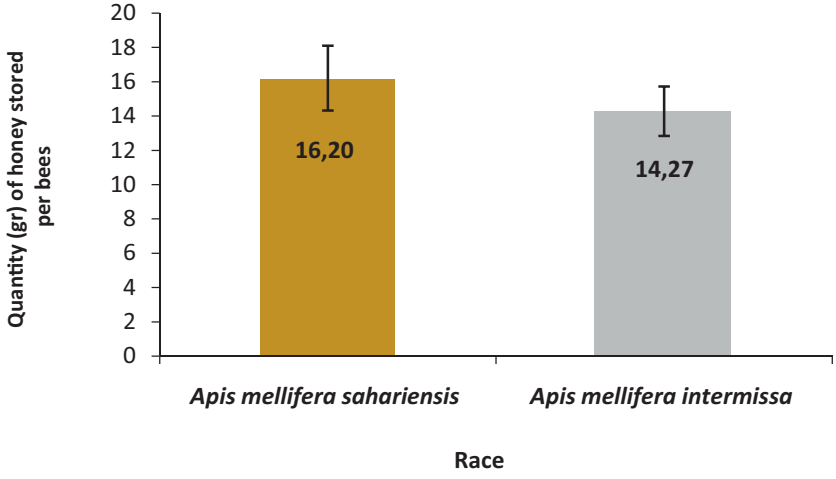

Figure 8 : Average honey production after 30 days for AMS and AMI subspecies.

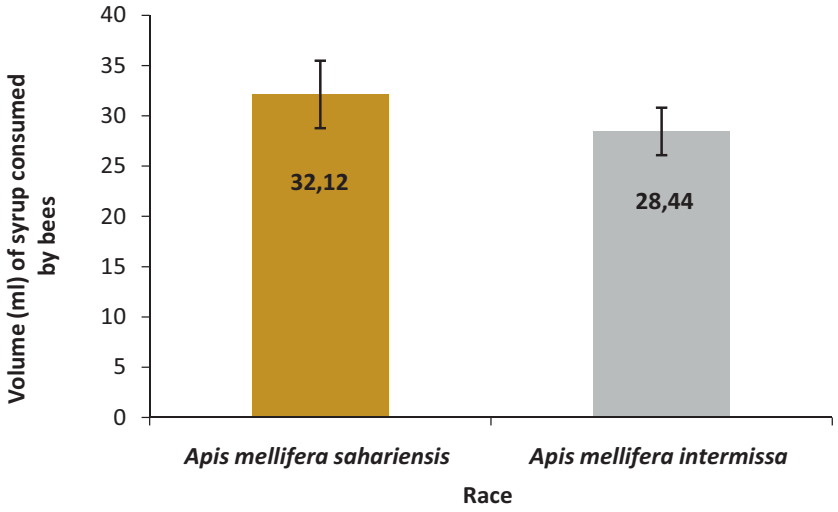

Figure 9 : Sucrose solution total consumption after 30 days of worker bees confinement.

Additionally, honey production period was shorter concerning AMS comparing to AMI with 14 and 20 days respectively, making thus AMS more efficient than AMI with an average of 22 mg/bee/day against 14.2 mg/bee/day.

Genotypic difference didn't explain either the variability in sucrose solution daily consumption by worker bees ($F< 0.224$), neither it explained ($F<0.813$) the differences in the overall (30 days) cumulative consumption (fig. 10). However, it was significant before the age 10±0.6 day ($F<0.005$) when AMI started honey deposit and day 16±1 ($F<0.005$) when AMS begin honey deposit. In both dates AMI consumed respectively 40.7% and 30,50% more sucrose solution than AMS. The tendency and proportions of consumption seem to have changed to AMS favour starting from the age 16 untill 30 days when AMS consumed in average 129.5% more than AMI.

On the other hand, genotype has induced (fig. 11) highly significant difference ($F<0.001$) in worker bees starting age of honey deposit. Indeed, while AMI started honey deposit in wax cells at age 10±0.6 day ; AMS delayed it until age 16±1 day ; confirming that *Apis mellifera* race has temporal division of labour among the workers (Giray, T., Guzman-Novoa, E., Aron, C.W., et *al.*, 2000) and that there is a large flexibility in the ages at which workers change duties (Michener 1974, Winston, 1991) as well as between genotypic lines (Pankiw and Page, 2001; Rueppell, O., Pankiw, T., Nielsen D.I., et *al.,* 2004).

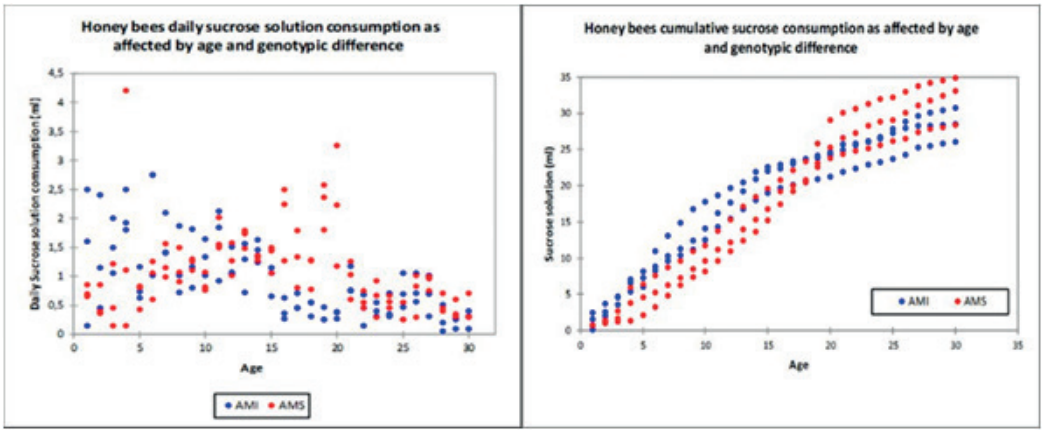

Figure 10 : Daily (left) and cumulative (right) sucrose solution consumptionas affected by honey worker bees genotype and age

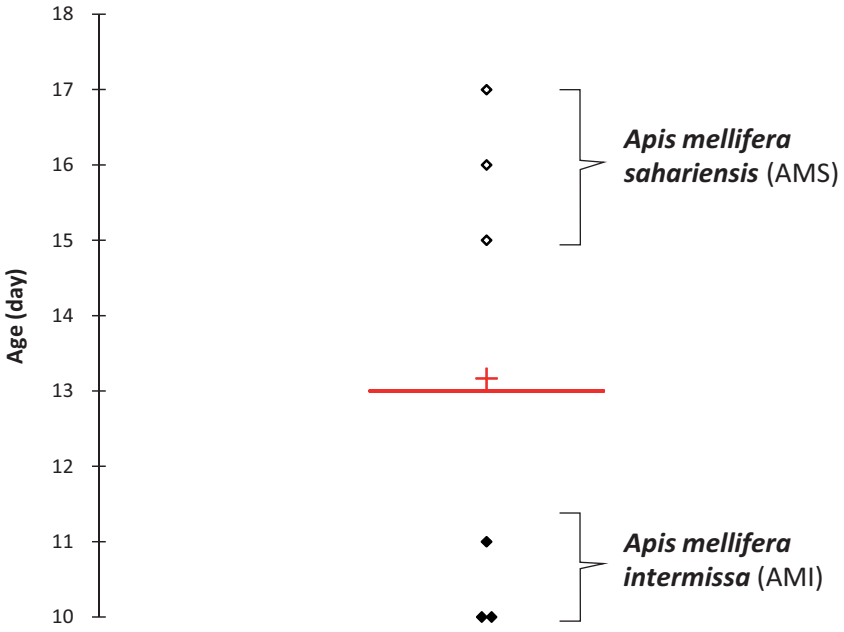

Figure 11 : Age by genotype of worker bees when starting honey deposit.

CONCLUSION

The objective of the study was to fill the knowledge gap regarding the most common local honey bees subspecies in Algeria. Three main behaviors were studied in laboratory : worker bees hoarding and honey production capacity as well as their honey deposit starting age. After 30 days of experimentation we can conclude that *Apis mellifera intermissa* and *Apis mellifera sahariensis* produced the same quantity of honey. However, genotype did explain differences in the consumption sucrose solution and most particularly the difference of age at which worker bees start honey deposit. AMI and AMS did produce the same quantity of honey but their behaviour is quite contrasted as their period of production, pick of sucrose consumption and honey deposit starting age didn't coincide at all. If it is related to their respective flowering time in their contrasted environments it should be explored more in further studies

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Variation and relationships among agronomic traits in Algerian sympatric populations of *Medicago minima* L. Bart. and *Medicago truncatula* Gaertn.