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Valorisation of date-palm by-products (DPBP) for livestock feeding in Southern Tunisia.

I – Potentialities and traditional utilisation

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SUMMARY – Date-palm by-products (DPBP) are classically used as a complementary feeding source for livestock by oasis people. However, little is known about traditional practices and methods for a local improvement of the use of DPBP. In this project we aimed at characterizing: (i) the quantitative and qualitative potentialities of these fodder sources; and (ii) the traditional uses of DPBP for livestock feeding. DPBP can be classified in wasted dates, stones, floral stems (lignified tissues supporting date fruits), panicles and leaves. Chemical composition of the by-products showed that, individually, they were highly unbalanced for animal nutrition: high energy content in the case of wasted dates and stones, high fibre content in the case of regime supports and palms. In both cases, crude protein (CP) content was usually low (3 to 6.5% of dry matter, DM). *In vitro* dry matter digestibility (IVDMD) was 74.5, 79.7 and 79.2% respectively in sheep, goat and dromedary for wasted dates, and 12.3, 19.6 and 18.3%, respectively for regime supports. A survey concerning a total of 84 livestock owners in the Nefzaoua region showed that farmers utilized mainly three types of DPBP to supplement small ruminants: wasted dates only (26%), a mix of all DPBP available (36%), and a mix of wasted dates and palms only (25%). A small proportion of farmers reported buying date stones for their flock in local markets, but this practice seemed closely linked with the presence of camelids within the herd. Products were usually offered without any treatment (38%), previously soaked in water to improve tenderness (26%) or mixed with straw, grasses or concentrate (19%). Farmers reported using DPBP each year during winter (63%), all the year (26%) or only during particularly dry years (11%). Quantities distributed varied depending on animal species, herd size, and structure of the production unit (0.2 to 1.2 kg/head of small ruminant/d). DPBP were viewed by locals as a relatively good and economic feeding source for small ruminants and dromedaries, using local natural resources and solving part of the problem of treatment of oasis wastes. 16% of farmers consider DPBP as a security fodder. Among limitations, the two main observations concerned problems of bloating when distributed with concentrates or bran, and seasonal unavailability.

Key words: Date-palm by-products, chemical composition, traditional utilization, arid Tunisia.

RESUME – "Valorisation des sous-produits du palmier dattier (SPPD) dans l'alimentation des animaux au Sud de la Tunisie. I – Potentiel fourrager et utilisation traditionnelle". Les sous-produits du palmier dattier (SPPD) sont classiquement utilisés comme compléments en alimentation animale dans le Sud tunisien. Dans cet article, nous avons tenté : (i) d'évaluer les potentialités quantitatives et qualitatives de ces ressources alimentaires ; et (ii) de mieux cerner les usages et fonctions des SPPD dans les systèmes alimentaires du Sud tunisien. Les SPPD peuvent être classés en 5 catégories : dattes de rebut, noyaux, hampes florales, panicules et feuilles. Les compositions chimiques de ces sous-produits ont montré que, individuellement, ils sont fortement déséquilibrés pour la nutrition animale : une concentration énergétique élevée dans les dattes de rebut et noyaux, des fortes teneurs en fibres dans les hampes et les feuilles. Par contre, dans tous les cas les teneurs en matières azotées totales (MAT) sont faibles (3 à 6,5% matière sèche, MS). Les mesures de digestibilité de la matière sèche (DMS) *in vitro* ont indiqué, pour les dattes de rebut, des valeurs de 74,5% chez les ovins, 79,7% chez les caprins et 79,2% chez les dromadaires, et, pour les hampes 12,3, 19,6 et 18,3%, respectivement pour les trois espèces considérées. Une enquête réalisée auprès de 84 unités d'exploitation dans la région du Nefzaoua a montré que les éleveurs utilisent les SPPD principalement sous trois formes : soit uniquement les dattes de rebut (26%), soit un mélange de tous les SPPD disponibles au sein de l'exploitation (36%), ou soit les dattes de rebut et les feuilles uniquement (25%). Une petite proportion d'éleveurs a déclaré acheter des noyaux de dattes, pratique qui apparaît très liée à la présence de camélidés dans le cheptel familial. Les sous-produits sont en général distribués sans aucun traitement préalable (38%). Cependant, d'autres pratiques ont été mentionnées, comme le trempage dans l'eau des dattes de rebut et des noyaux (26%), ou le mélange avec de la paille, du foin ou du concentré (19%). Les éleveurs ont déclaré distribuer les SPPD essentiellement durant l'hiver (63%), toute l'année (26%), ou seulement lors d'années particulièrement sèches (11%). Les quantités distribuées varient selon les espèces considérées, la taille du troupeau et la structure de l'unité d'exploitation (0,2 à 1,2 kg MS/tête de petit

ruminant/jour). Les SPPD sont perçus par les populations locales comme des ressources fourragères de bonne qualité et économiques. 16% des personnes enquêtées considèrent les SPPD surtout comme des aliments de secours. Leurs limites concernent les risques de météorisation quand les dattes de rebut sont distribuées avec du concentré et la saisonnalité de leur disponibilité.

Mots-clés : *Sous-produits du palmier dattier, composition chimique, utilisation traditionnelle, Tunisie aride.*

Introduction

Dates cultivation is the main activity in the oases found on the margins of the Sahara desert. In Tunisia, oases cover almost 40,000 ha and represent an original form of human development in very harsh climatic conditions. Livestock production is also an important component of oasian farming systems, due to its contribution for the maintain of soil fertility, human nutrition and power source (Dollé, 1990). However, livestock feeding is frequently problematic, despite a relatively high diversity of feed sources (Tisserand, 1990). Among these, date-palm by-products (DPBP) can be a significant source of feed. Belal *et al.* (1999) mentioned that, in Saudi Arabia, about 20% of the total date production is unsuitable for human consumption and wasted. Others by-products derived from date cultivation, such as leaves, and floral stems supporting date regimes may be useful in animal feeding. Some studies evaluated chemical composition and nutritive value of mainly wasted dates and stones (Hadjipanayiotou and Rihani, 2000). However, little is known about their traditional integration in the feeding systems and the modalities of uses of these local forage resources.

In this study, we carried out: (i) quantitative and qualitative measurements in order to evaluate availability and nutritive value of the different DPBP found in southern Tunisia; and (ii) a survey in the Nefzaoua region in order to document the traditional utilisation of DPBP in livestock production. The final objective was to plan a research project oriented toward a better utilisation of DPBP for the benefit of local oasian farmers.

Material and methods

DPBP forage evaluation

Samples of wasted dates, stones, leaves, floral stems were collected in different places representing two locally dominant varieties: Deglet Nour for the Nefzaoua region, and Kentah for the El Hamma region. Samples were analyzed for dry matter (DM), crude protein (CP), total ash and crude fibre (CF) by standard procedures (AOAC, 1975). Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined according to Goering and van Soest (1970) using the automated ANKOM fibre analyser.

In vitro digestibility (Tilley and Terry, 1963) measurements were realized on each sample, using rumen juices from three species: sheep, goat and dromedary. For each animal species, the microbial inoculum was obtained from mixed rumen juice of three adult animals recently slaughtered in the surrounding commercial slaughter-houses of the city of Medenine, maintained at 38°C, and quickly transported at the laboratory. Measurements of DM disappearance after 48-hours incubation of each DPBP sample were repeated in triplicate.

Preliminary biomass estimation

Data presented in this paper are taken from a more extensive study on agronomic aspects of date-palm cultivation, realised during 5 years at the *Institut des Régions Arides, Antenne de Kebili (Nefzaoua)*. Measurements were made on fifty 10 to 15 years-old trees from Deglet Nour variety, conducted at a density of 100 trees/ha, and involved phenological and pomological criteria such as: height, stem diameter, number of green and dry palms, number of regimes, total weight of regime, weight of commercial dates, weight of wasted dates, etc. Values presented further below are averages from 5 years (1995-2000), and concern only parameters potentially useful for our purpose.

Survey

An explorative survey was realised on 84 production units of the Nefzaoua region owning livestock in order to characterise the place of DPBP in the alimentary systems of the region and to show the interests and limits of these forage resources perceived by local farmers. This survey followed a previous extensive socio-economical survey realised in a sub-region of Nefzaoua (El Faouar) concerning the relationships between human population and environment¹ (DYPEN, 2000). Opened questions concerned:

- (i) The use of DPBP in livestock feeding (types of by-products, varieties, etc.).
- (ii) Modalities of distribution (types of animals, periods of distribution, quantities, feed treatments (none, chopped, mixed with other feeds, previously soaked in water, grounded, etc.).
- (iii) Commercialisation and perceptions (interests, limits, sanitary problems, other uses, etc.).
- (iv) The structure of production unit (types and number of animals, date palm number cultivated, forage crops, dependence upon rangelands, etc.).

Data were processed through the analysis of dynamic crossed tables and a factorial analysis of multiple correspondences (Benzecri, 1973). This technique provides a non-parametric description of the relationships between variables and gives an indication to their importance rather than a measure of significance. Data treatment were carried out using the STATBOX software.

Results and discussion

Herd structure varied widely among households (4 to 400 ovine units, OU), but the great majority of livestock owners possessed small to medium herd of mixed small ruminants (mean 28 sheep and 18 goats) (Table 1). Dromedaries flocks are raised marginally (13 households declared owning camelids, and among them only 5 possessed more than 10 heads). The function of the herd is primarily to provide milk and meat for rituals and feasts (Aid, marriage, etc.). However 18% of farmers declared that livestock production constitutes their first source of income.

Table 1. Type and size of herds found in Nefzaoua region (percent of households)

Camels herds (>10 heads)	Big flocks of small ruminants (>80 OU)	Medium flocks of small ruminants (20-80 OU)	Small flocks of small ruminants (<20 OU)
5	19	44	32

Most of livestock owners use DPBP for feeding livestock in the Nefzaoua region. The DPBP principally distributed are: (i) a mix of all DPBP available, indistinctly (37% of household surveyed); (ii) only wasted dates (33%); and (iii) only wasted dates and leaves (26%). A small proportion declared using stones (4%) destined to dromedaries. DPBP are usually eaten by all animals of the flock, whatever their physiological stage. In 10% of the cases they are reserved for sheep fattening.

Date-palm sub-products are distributed essentially during winter in 63% of the cases, while some herders distribute them all the year (26%) and some only during particularly dry years (11%). These data point out the multiple interests DPBP can offer: they can constitute a "structural" complementation of the daily diet or be reserved for special event such as periods of high nutritional requirement levels (lambing/kidding), periods that require a high energetic forage source for combating cold, or as substitutive forage in case of scarcity.

¹ This extensive survey was conducted within the collaborative research project DYPEN (Dynamique des Populations et Environnement en Tunisie rurale) leaded by Institut des Régions Arides (IRA) and Institut de Recherche pour le Développement (IRD). Among the 456 households surveyed, 52% declared owning livestock, generally small herds (<20 OU) of small ruminants (Genin, 1999; DYPEN, 2000).

Distribution of DPBP without any treatment remains the classical figure (40% of farms surveyed). However, according to livestock farmers, a previous soaking of wasted dates and stones (12 to 24 h) increase their palatability (26% of farms declared practising this technique). Grinding (9% of farms) is perceived as an interesting technique to improve the nutritive value of wasted dates and stones, but is difficult to work up due to the hardness of the products. Few local commercial enterprises offer this service (in 2000, cost of grinding was 0.750 DT/25 kg²; ground stones were also sold at the cost of 10 DT/50 kg). 25% of households declared mixing DPBP with other feeding sources; products most used are: bran (67%), straw (17%), green grass and alfalfa (12%) or olive cake (5%). The mix of DPBP with bran is however mentioned by several livestock owners as to be used with caution because of high risks of bloating.

Trade of wasted dates and stones is widespread on local markets. Availability and prices highly fluctuate between seasons and years. In the year 2000, a 20 kg-chest of wasted dates was offered at a mean price of 1.5 DT on local Nefzaouan markets during winter. In our survey, 47% of households declared purchasing DPBP, while 21% were selling wasted dates. 15% of households declared having problems of supply.

Despite an unbalanced chemical composition, DPBP are perceived as good forages in 46% of the cases, particularly wasted dates for their high energy content. They are also viewed as security feeds (26% of the answers). Concerning their limits, risks of bloating when associated with bran is widespread mentioned (73%), and problems of seasonal availability.

The factorial analysis of multiple correspondences allowed a discrimination of households according to the relationships between modalities of variables related to the uses of DPBP in livestock feeding. The first three axes contributed for 48.2% to the total inertia. Modalities of the variable related to herd structure highly determined F1 and F3 axes, whose plan was then privileged for interpretations. The most sensitive variables on these axes were the types of DPBP used, the distribution modes of DPBP, date-palm ownership, and the importance of forage crops. Livestock farms surveyed were set into three groups whose characteristics are resumed hereafter:

(i) Small to medium flock of small ruminants (<50 OU), highly linked with the agricultural productions of the oases. Feeding system is based on a weak grazing on rangelands surrounding the oasis³ and an intensive distribution of cultivated forages (green alfalfa and barley). DPBP are widely used for livestock feeding, usually mixed with bran, alfalfa or grasses. Quantities of DPBP per animal per day tend to be important (around 1 kg of mixed products/small ruminant/day).

(ii) Big flocks of small ruminants (>80 heads) based basically on the use of surrounding and remote rangelands. Production unit structures are weakly linked with the oasis (low date palm ownership, low forage crops). Livestock owners distribute purchased wasted dates without any treatment during winter. Others feed supplements are separately distributed.

(iii) Dromedary herds, associated with production units presenting high quantities of palm dates and using DPBP seasonally, mixed with bran or olive cake. The use of stones is highly associated with this type of herds.

Estimation of biomass of DPBP

Production of date-palms highly fluctuates depending upon the variety, age of trees and climatic conditions of the year, particularly during fruit maturation. During this period two climatic events are particularly feared by peasants: precipitation which can result in fermentation of fruits, and high temperatures (>40°C) which dry dates. It is estimated that between 5 and 30% of the dates production is lost. Table 2 shows preliminary data, of potentially available DPBP per hectare for livestock feeding in southern Tunisia. These sub-products are weakly valorised elsewhere, with the exception of palm which are sold at a medium price of 0.05 DT/palm for sailing activities or anti-erosion barriers.

² 1 DT (Tunisian dinar) = 0.66 US\$ or 0.75 euro.

³ Grazing is usually collective with a salaried person herding various village's household flocks during the day and devolving animals to their owners at the final of the day.

Table 2. DPBP biomass potentially available for livestock feeding in the Nefzaoua region

kg DM/ha (averages)	
Dry palms (15 to 25/tree/year)	3600
Wasted dates (green, immature, dry, rotten)	950
Dry weight of peduncles and pedicles [†]	2550
Total	7100

[†]Floral stems supporting date fruits.

Nutritive value

The two varieties of date-palm analysed here presented a similar chemical spectrum (Table 3). Globally, wasted dates and stones are highly energetic feeds. According to Sawaya (1983) date flesh contains 733 g total sugar/kg. Guessous *et al.* (1985) reported a mean of 461 g hydrosoluble carbohydrates/kg DM in wasted dates. All DPBP have low CP contents (<7%) as found in literature. Moreover, CP digestibility was found to be low (about 20%) for date seeds (Gihad *et al.*, 1989). Vegetative parts (leaves and stems) have characteristics of roughages with high contents of structural tissues.

Table 3. Chemical composition (in percent DM) of date-palm by-products of two date-palm varieties from Tunisia (means of three samples)

	DM	CP	CF	NDF	ADF	ADL	Ash
Wasted dates DN [†]	84.2	4.5	7.4	22.2	18.0	9.3	4.4
Wasted dates K ^{††}	74.7	4.9	8.8	26.6	17.7	9.4	4.4
Leaves DN	64.8	5.1	40.4	75.8	58.7	22.0	11.6
Floral stems DN	45.5	3.2	50.5	83.4	58.9	16.0	9.2
Floral stems K	37.7	3.1	48.8	82.4	55.1	13.4	7.9
Stones DN	89.5	6.4	20.6	57.5	41.2	18.4	6.8
Stones K	89.3	6.6	21.7	65.0	46.3	13.4	7.7

[†]DN: Deglet Nour variety.

^{††}K: Kentah.

In vitro dry matter digestibility (IVDMD) of DPBP are shown in Table 4. Leaves and stems have low IVDMD (<25%) with a tendency of lower values in sheep, compared with goat and dromedary. These results fit with those reported by Kayouli *et al.* (1991) who mentioned higher digestion of low quality forages in dromedary respect to sheep. Similar observations were made by Genin and Tichit (1997) in the case of south American camelids, who found their explanation in differentiated composition and activity of the forestomach and intestinal floras of these animal species. Concerning wasted dates, data showed high IVDMD (>70%) confirming the high energetic value of these by-products. IVDMD of stones showed significant lower values than data found by Gihad *et al.* (1989) in sheep and dromedary, and will have to be confirmed.

Conclusion

DPBP are interesting alternative animal feed sources traditionally used in the oasian agro-pastoral systems. Hence, as Roggero *et al.* (1996) argue, special attention must be given to existing situations in which livestock farmers already use a diversity of resources, and to enhancing system adaptability. Emerging sustainability concerns are challenging both prevailing situations and our ability to assess or suggest alternative feeding systems. In this study, we aimed to primarily learn more about farmer's knowledge on these original local forage resources, in order to be able to target innovations better adapted to real farming situations. Two major problems were found in the use of DPBP: (i) how to

easily make out a more balanced DPBP-based forage? and (ii) how to conserve it to solve the problem of seasonal unavailability? These questions led to test DPBP-based silages in order to improve the use of these local forage resources (Khorchani *et al.*, this volume).

Table 4. *In vitro* dry matter digestibility (IVDMD) of date-palm by-products from two date-palm varieties in sheep, goat and dromedary

	Sheep	Goat	Dromedary
Wasted dates DN [†]	76.7 ± 1.8 a	75.7 ± 0.7 a	80.9 ± 5.2 a
Wasted dates K ^{††}	72.2 ± 1.3 a	83.7 ± 5.4 b	77.4 ± 3.6 ab
Leaves DN	14.6 ± 2.8 a	17.4 ± 2.2 a	16.7 ± 1.2 a
Floral stems DN	12.6 ± 2.1 a	13.8 ± 1.1 a	22.4 ± 0.9 b
Floral stems K	12.0 ± 1.7 a	25.1 ± 3.2 b	14.2 ± 2.9 a
Stones DN	31.9 ± 1.4 a	60.3 ± 1.3 b	34.5 ± 1.6 a
Stones K	30.0 ± 2.6 a	51.6 ± 2.7 b	33.7 ± 1.4 a

[†]DN: Deglet Nour variety.

^{††}K: Kentah.

^{a,b}Within row, means with different letter significantly differ (P < 0.01).

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