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Yield and chemical composition of Morrocan chickpea (*Cicer arietinum* L.) genotypes crop residues

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Abstract. Food legumes crop residues are a valuable forage resource in low rainfall areas with a high integration of crops to livestock. Since 1987, eighteen varieties of chickpea are recorded based on their grain yield, tolerance to drought and diseases in the Moroccan official catalog. However, till now there is a lack of studies targeting the food legume crop residues yield and quality. Thus, the aim of this study is to evaluate the yield and the chemical composition of eight Morrocan chickpea genotype residues. Four varieties (Farihane, Arifi, Zahour, Douyet) and four advanced genotypes (Flip85-1C, Flip97-190C, Flip97/114C, Flip97-677C) were arranged in randomized complete block design with four replications in 2016 at Jmaat Shaim experimental station. The harvested residues were dissected into stem segments and leaves. The Flip97-677C showed the highest crop residue yield 3.63 t/ha. The leaves proportion ranged from 44% for Flip85-1C to 49% for Flip97-190C. The crude protein (CP) content ranged from 63 to 89 g/kg DM, with Flip97-677C showing the highest CP. Neutral detergent fiber, acid detergent fiber and acid detergent lignin contents ranged from 568 to 661, 378 to 435 and 99 to 108 g/kg DM respectively. The average value of ash was 885 g/kg DM. The leaves had higher protein and ash contents and lower levels in different fiber parameters than stems for all genotypes.

Keywords. Chickpea genotypes – Crop residues – Yield – Morphological fractions – Chemical composition.

***Rendement et composition chimique des fanes de quelques génotypes marocains de pois chiche* (Cicer arietinum L.)**

Résumé. *Dix-huit variétés de pois chiches ont été répertoriées sur la base de leur rendement en grains, de leur tolérance à la sécheresse et aux maladies dans le catalogue officiel marocain depuis 1987. Cependant, peu d'études ont été consacrées au rendement et à la qualité de leurs fanes. L'objectif de cette étude est d'évaluer le rendement et la composition chimique des fanes de pois chiche de huit génotypes: quatre variétés (Farihane, Arifi, Zahour, Douyet) et quatre lignées prometteuses (Flip85-1C, Flip97-190C, Flip97 / 114C, Flip97-677C). Les génotypes ont été disposés en blocs aléatoires complets avec quatre répétitions en 2016 à la station expérimentale Jmaat Shim. Les fanes récoltées ont été disséquées en segments de tiges et de feuilles. Le Flip97-677C a montré le rendement le plus élevé en fanes soit 3,63 t/ha. La proportion de feuilles dans les fanes a varié de 44% pour Flip85-1C à 49% pour Flip97-190C. La teneur en protéines brutes (PB) a oscillé entre de 63 à 89 g/kg MS. Le Flip97-677C avait la teneur la plus élevée en PB. Les teneurs en fibres détergentes neutres, en fibres détergentes acides et en lignine détergente acide ont varié de 568 à 661, 378 à 435 et de 99 à 108 g/kg MS, respectivement. La valeur moyenne des cendres a été de 885 g/kg MS. Les feuilles ont des teneurs en protéines et en cendres plus élevées et des teneurs en différents paramètres de fibres plus faibles que les tiges pour tous les génotypes. Les fanes de légumineuses alimentaires constituent une ressource fourragère précieuse dans les zones à faible pluviométrie où l'élevage est fortement lié aux cultures*

Mots-clés. *Variétés pois chiche – Fanes – Rendement – Fractions morphologiques – Composition chimique.*

I – Introduction

Food legumes, grown for their seeds, play an important role in crop rotation with cereals in rainfall agriculture. Recently, in Morocco, food legumes have regained interest through the national agricultural strategy «Plan Maroc Vert» which aims to increase production fivefold in several regions. This suggests a greatly increased availability of grains and straws. At the national level, no work has been done to evaluate the yield and chemical composition of these residues, although elsewhere the differences in the nutritive characteristics of straws result from variations in the proportions of morphological fractions, genotype and environmental factors (Capper, 1988). These criteria can be assets in low rainfall areas where there is a large integration of livestock to agriculture and the feed resources for ruminants are limited. This study was carried out to evaluate the yield of eight Moroccan chickpea genotypes straws and to determine the chemical composition of their morphological fractions.

II – Materials and methods

Eight Moroccan chickpea genotype straws were studied including four varieties (Arifi, Douyet, Farihane, Zahour) and four promising lines (Flip97-190C, Flip 97-114C, Flip97-677C and Flip85-1C). The agronomical trial was conducted in 2016 at Jmaat Shaim experiment station. The genotypes were arranged in a randomized complete block design with four replications. Each plot was of two rows of four meters long with a spacing of 0.5 m. The total biomass was collected from each elemental plot and weighed just after harvest. The seeds were separated from the leaves and stems for each genotype and each repetition. A sample of each component of each genotype and each replicate was ground to pass through a 1 mm screen and stored for chemical analysis. Dry matter (DM) was determined by drying the samples at 50°C untill constant weight and ash by burning the samples in muffle furnace at 550°C for 4 h. Detergent fibre fractions (neutral detergent fibre (NDF), acid detergent fibre (ADF) and 72% sulfurous acid lignin residual ash (ADL)) were determined using the method of Van Soest (1967). The crude protein (CP) was determined by Kjeldahl method (Association of Official Analytical Chemists (AOAC), 1990). The analysis of the variance was completed by the Newman and Keuls mean comparison test.

III – Results and discussion

The genotype had a significant effect on the straw yield, the straw to total biomass, and leaves to straw proportions. The average straw yield was 30 q / ha with a minimum of 26.9 q / ha for Flip97-190C and a maximum of 36.3 q / ha for Flip97-677C. This straw yield corresponded to an average proportion of 60% of the total biomass. The leaves to straw proportion was on average 46.5% (Table 1) and therefore the fraction of the stems exceeded the half (53.5%). This suggests that the nutritive value of straw will depend on the chemical composition of the stem (Xing *et al.*, 1993). Except Arifi variety, others showed higher content of CP (Table 2) compared to one found (6.1% DM) by Bruno-Soares *et al.*, (2000). Beside, the recorded CP values were greater than those reported in cereal straw by Assioua (1990).

The ash content of the different genotypes was 8.85 % DM. This value was twofold of that found by Bruno-Soares *et al.*, (2000) and was higher than what was found for chickpea straw in France (Yaméogo *et al.*, 1991). Arifi variety had greatest ash content (12.2% DM) and Flip97-190C had the lowest ash content (6.9% DM). These values were close to those reported by Ben Slimane (1988) and Assioua (1990) in cereal straw

The average values of cell walls, including NDF, ADF and ADL, were 59, 40 and 10% DM respectively. These values were lower than those reported by Bruno-Soares *et al.*, (2000) (76.5, 59.6 and 14.2% DM, respectively). The lignin content of chickpea straw is almost twofold of the cereal straw (Muñoz, 1991). This suggests the low digestibility of chickpea compared to cereal straws.

Table 1. Yield of eight Moroccan chickpea genotype straws

	Straw yield (q)	Straw proportion (%)	Leaves to straw proportion (%)
Arifi	29.9^{b}	58.2^{d}	41.2^{e}
Douyet	30.7^{b}	60.6^{b}	45.4^{d}
Farihane	30.5^{b}	60.2^{c}	47.7^{c}
Zahor	28^{c}	58.2^{d}	47.6^{c}
Flip85-1C	31.1^{b}	62^{b}	44.7^{d}
Flip97-190C	26.9^{d}	61.4^{b}	49.4^{a}
Flip 97-114C	28.6^{c}	59.4^{c}	48.5^{b}
Flip97-677C	36.3^{a}	63.8^{a}	47.2^{c}
Average	30.2	60.5	46.5

Values in the same columns followed by different letters are significantly different (P < 0.05).

Table 2. Chemical composition of eight Morrocan chickpea straws

	Ash (%DM)	CP (%DM)	NDF (%DM)	ADF (%DM)	ADL (%DM)
Arifi	12.2	4.4	57.8	40.1	10.2
Douyet	9.7	6.9	58.9	41.3	10.8
Farihane	9.1	7.4	57.3	38.6	10.3
Zahour	8.3	8.3	61.1	43.5	10.8
Flip85-1C	7.6	7.5	60	39.6	10.1
Flip97-190C	6.9	7.4	58.5	38.2	10
Flip 97-114C	8.7	6.3	59.7	42.3	10.6
Flip97-677C	8.3	8.9	56.8	37.8	9.9
Average	8.85	7.14	58.76	40.17	10.34

The chemical composition of different fractions varied according to the genotypes. The ash and crude protein contents of the leaves were higher than those of the stems. However, the cell wall contents (NDF, ADF and ADL) of the stems were higher than those of the leaves (Table 3). This result was in agreement with that found for other forages (Fekede *et al.*, 2008, Tan *et al.*, 1995). Arifi variety had the lowest (P < 0.05) proportion of leaves and the lowest protein content.

Table 3. Chemical composition of leaves (L) and stems (S) of eight Morrocan chickpea straws

	Ash (%DM)		CP (% DM)		NDF (% DM)		ADF (% DM)		ADL (% DM)	
	L	S	L	S	L	S	L	S	L	S
Flip85-1C	10.4^{a}	9.4^{a}	10.4^{b}	9.4^{b}	44.8^{bc}	62.2^{ab}	25.7^{bc}	47.7^{ab}	7.7^{c}	12.5^{b}
Douyet	10.7^{a}	7.1^{a}	10.7^{b}	7.1^{ab}	41.9^{b}	61.1^{ab}	25.2^{b}	45.7^{ab}	7.2^{bcd}	11.3^{ab}
Farihane	12.0^{a}	5.9^{a}	12.9^{b}	5.9^{a}	40.1^{b}	61.8^{ab}	23.9^{b}	47.1^{ab}	6.0^{ab}	12.2^{ab}
Arifi	11.9^{a}	8.0^{a}	5.4^{a}	4.3^{a}	50.1^{c}	58.3^{a}	28.3^{c}	43.8^{a}	8.3^{d}	10.6^{a}
Zahor	10.8^{a}	6.5^{a}	13.7^{b}	3.7^{a}	43.2^{bc}	61.1^{ab}	25.3^{b}	46.2^{ab}	6.8^{abc}	11.3^{ab}
Flip97– 90C	11.5^{a}	7.5^{a}	13.5^{b}	4.6^{a}	32.6^{a}	63.9^{b}	20.1^{a}	48.5^{b}	5.5^{a}	13.0^{b}
Flip97– 14C	9.2^{a}	5.2^{a}	11.2^{b}	4.1^{a}	45.5^{bc}	64.6^{b}	26.7^{bc}	48.7^{b}	6.8^{abc}	12.7^{b}
Flip97– 77C	9.2^{a}	5.2^{a}	12.4^{b}	5.5^{a}	42.9^{bc}	61.4^{ab}	25.0^{b}	46.0^{ab}	6.6^{abc}	12.1^{ab}
Average	10.7	6.8	11.3	5.6	42.6	61.8	25.0	46.7	6.9	11.9

Values in the same columns followed by different letters are significantly different (P < 0.05).

IV – Conclusions

Results obtained in this work showed significant differences between the eight Morrocan chickpea genotypes studied in straw yield, straw proportion in total biomass and leaves to straw proportion. The leaves were characterised by high protein and ash contents and lowest cell wall content than stems. These straws had an interesting productive potential and a better nutritional quality than cereal straws. Further studies are needed to determine the effect of substituting cereal straw with chickpea straw in ruminant diets.

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