

## Nutrient Contents and Gossypol Levels of Cotton Seed Meal Produced in Hatay Region of Turkey

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The aim of the study were to determine the nutrient contents and gossypol levels of upland type (*Gossypium hirsutum*) whole cotton seed and cotton seed meal produced in Hatay region of Turkey as an important potential raw material for animal feeding operations. The whole cotton seed and cotton seed meal materials were seven commercial hybrid seeds, expeller (13 samples) and extraction system (1 sample), respectively. Nutrient analyzes showed that there were significant differences between whole cotton seeds with respect to dry matter (DM), organic matter (OM), ether extract (EE) and ash contents ( $p < 0.01$ ) while crude protein (CP), nitrogen free extract (NFE) and crude fiber (CF) were not significant between each other ( $p > 0.05$ ). Free gossypol levels of whole cotton seed were 0.362, 0.440, 0.478, 0.493, 0.510, 0.526 and 0.591 % in GW-Teks, BA-151, BA-320, SG-125, BA-119, Sahin 2000 and BA-308 samples, respectively. The crude protein and ether extract contents of expeller and extraction cotton seed meal were determined 21.50, 40.14 and 9.16, 1.30 %, respectively. Free gossypol level of either extraction or expeller cotton seed meal was 0.06 % in average and no significant difference ( $p > 0.05$ ). Both nutrient contents and gossypol levels of whole cotton seed and cotton seed meal seemed to be similar with the reported results, except the crude protein content of expeller cotton seed meal.

**Key Words:** Whole cotton seed, Cotton seed meal, Nutrient contents, Gossypol level.

### INTRODUCTION

Cotton is a major crop throughout the world and by-products of the cotton industry such as linted whole cotton seed (WCS) and cotton seed meal (CSM) are frequently used in ruminant diets to provide energy, fiber and protein<sup>1,2</sup>; however, its use is typically limited by the gossypol content. There have been many factors contributing to variation in the nutrient and gossypol content of cottonseed. Type of cotton, variety and growing conditions are important sources of variation, but harvesting and storage conditions and processing can also have an impact.

Gossypol is a yellow, polyphenolic aldehyde compound, which is present in the highest concentrations in whole cotton seed pigment glands<sup>3</sup>.

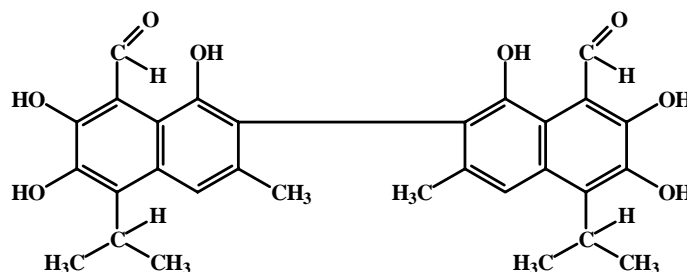


Fig. 1. Chemical formula of gossypol (source: [www.bioscreening.net](http://www.bioscreening.net))

Gossypols exist in whole cotton seed (WCS) in both free and bound forms. Most gossypol found in WCS is in the free form, but some becomes bound due to the heat, moisture and pressure associated with cotton seed meal (CSM) of WCS processing<sup>4,5</sup>.

Direct-solvent extraction procedures of cotton seed production have resulted in cotton seed meal with a greater quantity of physiologically active free gossypol than other oil extraction methods<sup>6</sup>. The expeller method used heat which increased the protein binding, thus converting more free gossypol to the bound form. CSM meal is a popular protein supplement for both beef and dairy cattle nutrition; however, several authors have reported<sup>7-10</sup> detrimental affects on physiology and reproductive performance in cattle due to the higher free gossypol content of some processed cotton seed meal. The toxic effects of gossypol are greater for non-ruminants than for ruminants, due to the binding of gossypol to soluble proteins in the rumen<sup>11</sup>. However, excessive cotton seed ingestion can overwhelm the detoxifying capabilities of the rumen and cause gossypol toxicities<sup>7,8</sup>.

In 2004 crop season, there were 640 045 ha cotton cultivated area in Turkey, which is harvested in this area 2,455,071 metric ton cotton and 1,425,850 metric ton WCS<sup>12</sup>. Hatay province provide 10.33 % (63 291 ha) and 8.73 % (258 785 t), whole cotton cultivated area and raw cotton product level of Turkey, respectively<sup>13</sup>.

In Turkey even though lots of cotton hybrid have been used in cotton production. There has been lack of information their CSM regarding the chemical contents of them. Also, whole cotton seed (WCS) and cotton seed meal (CSM) was mainly ingredient of concentrate feed in Turkey. For this reason, we have to know gossypol level of WCS or CSM used for animal nutrition. The aims of the study were to determine the nutrient contents and gossypol levels of WCS and CSM produced in Hatay region of Turkey as an important potential raw material for animal nutrition.

## EXPERIMENTAL

Seven commercial hybrid seeds (BA-119, BA-308, BA-320, BA-151, GW Tekes, SG-125 and Sahin 2000) and 14 CSM samples (13 of expeller and 1 of extraction method) were collected for this study from Hatay region. Nutrient content of either seeds or meals were analyzed by AOAC procedure<sup>14</sup>. Whole cotton seed (WCS)

and cotton seed meal (CSM) were analyzed for total<sup>15</sup> and free gossypol<sup>16</sup> levels according to the procedures of the AOCS with using Perkin-Elmer 25 UV/Vis spectrophotometer. The main factor was cotton hybrids in whole seed analysis. The method of CSM production is the factor in CSM analysis.

Data concerning were analyzed using one-way ANOVA procedure (Windows version of SPSS, release 10.01). Differences among means were tested using Duncan's multiple range test.

## RESULTS AND DISCUSSION

**Nutrient content:** Seven upland type cottonseed varieties grown in Hatay region were analyzed. One of them was delinted (BA 320) and the others were linted seeds. The dry matter (DM), crude protein (CP), ether extract (EE) and crude fiber (CF) % in BA-320 variety was 93.45, 19.32, 31.70 and 7.95 %, while linted varieties range from 92.95 to 94.15, 16.75 to 24.44, 24.80 to 30.10 and 12.87 to 17.78 %, respectively (Table-1).

TABLE-1  
NUTRIENT CONTENT OF WHOLE COTTON SEED (WCS)

Variety	DM (%)	Ash (%)	CP (%)	EE (%)	OM (%)	NFE (%)	CF (%)
BA-119	93.40 ± 0.00b	3.55 ± 0.05 a	16.75 ± 1.23	24.80 ± 0.60 a	89.85 ± 0.05 b	34.29 ± 0.01	14.00 ± 0.70
BA-308	94.15 ± 0.15c	3.60 ± 0.00 ab	20.66 ± 0.06	30.10 ± 0.70 cd	90.55 ± 0.15 c	24.87 ± 1.26	14.91 ± 0.35
BA-320	93.45 ± 0.15b	4.25 ± 0.05 d	19.32 ± 3.52	31.70 ± 0.82 d	89.20 ± 0.10 a	30.22 ± 2.37	7.95 ± 0.22
BA-151	93.20 ± 0.20ab	4.00 ± 0.10 cd	19.14 ± 0.02	29.67 ± 0.93 cd	89.29 ± 0.30 a	26.96 ± 1.57	13.42 ± 0.92
GW Teks	93.55 ± 0.05 b	3.85 ± 0.15 bc	18.13 ± 2.25	28.37 ± 0.17 bc	89.70 ± 0.10 b	25.42 ± 6.09	17.78 ± 3.57
SG-125	92.95 ± 0.05 a	3.55 ± 0.05 a	20.00 ± 0.81	25.47 ± 0.27ab	89.40 ± 0.00 ab	29.11 ± 3.51	14.81 ± 2.43
Sahin 2000	93.20 ± 0.10ab	3.50 ± 0.10 a	24.44 ± 4.42	27.45 ± 1.70abc	89.70 ± 0.00 b	24.93 ± 3.70	12.87 ± 0.99
p	< 0.01	< 0.01	>0.05	< 0.01	< 0.01	>0.05	>0.05

a,b,c = Values are difference between variety. DM = Dry matter, OM = Organic matter, EE = Ether extract, CP = Crude protein, NFE = Nitrogen free extract, CF = Crude fiber.

Nutrient analyzes showed that there were significant differences between WCS's with respect to DM %, OM %, EE % and ash % contents ( $p < 0.01$ ), while CP %, NFE % and CF were not significant between each other ( $p > 0.05$ ). The higher EE % was determined in BA-320 variety. Delinted seeds generally might have higher ether extract concentrations than linted ones.

Nutrient contents of WCS, DM, EE level were higher to those of<sup>5,17-19</sup>; CP and CF were lower than through these reports. However, similar nutrient content were found in WCS in India<sup>19</sup>. Good ginned cotton seed is nearly lint free, thus it was lower CF %.

The differences of producing method (expeller or solvent extraction) of CSM with respect to nutrient content were given Table-2.

TABLE-2  
EFFECTS OF DIFFERENT PRODUCING METHOD ON CSM NUTRIENT CONTENT

Item	DM (%)	Ash (%)	CP (%)	EE (%)	OM (%)	NFE (%)	CF (%)
Exp.	94.52 ± 0.29a*	5.99 ± 0.13a	21.50 ± 1.43a	9.16 ± 0.91a	88.56 ± 0.29a	38.40 ± 1.90a	19.48 ± 0.64a
Extr.	92.35 ± 0.05b	6.60 ± 0.00b	40.14 ± 0.49b	1.30 ± 0.30b	85.75 ± 0.05b	30.44 ± 0.62a	13.87 ± 0.76b
p	<0.01	<0.05	<0.01	<0.01	<0.01	>0.05	<0.01

a,b,c : Values are difference between item.

The difference between expeller and solvent extraction CSM were highly significant as expected in CP, EE, OM and CF % ( $p < 0.01$ ). The CP increases and EE decreases during processing according to the methods used. CSM is an excellent protein supplement for cattle. It has a relatively low rumen degradability and it is therefore a good source of by-pass protein and especially useful in rations for milking cows<sup>20</sup>.

Papadopoulos and Ziras<sup>21</sup> reported that, forty-two solvent extraction Greek cotton seed ranges in composition were CP 41.1-48.3 %. Also, present study was similar CP (40.14 %) for solvent CSM.

**Total and free gossypol:** Total and free gossypol level of commercial cotton seed variety in which used as a materials were given in Table-3. The mean value for free gossypol of variety as obtained to 0.362-0.591 %.

TABLE-3  
TOTAL AND FREE GOSSYPOL LEVEL OF COTTON VARIETY

Variety	Total gossypol		Free gossypol	
	ppm	%	ppm	%
BA-119	14510	1.451	5097	0.510
BA-308	12698	1.270	5908	0.591
BA-320	9658	0.966	4782	0.478
BA-151	9157	0.916	4395	0.440
GW Teks	5109	0.511	3624	0.362
SG-125	8429	0.843	4931	0.493
Sahin 2000	12083	1.208	5262	0.526

The highest free gossypol level was in BA-308 variety (0.591 %) and lowest free gossypol level was in GW-Teks variety (0.362 %). There were no statistical differences between WCS variety ( $p > 0.05$ ).

The amount of free gossypol in the cotton seed can be quite variable. Many factors influence gossypol content such as; species of cotton plant, climatic conditions,

soil conditions, fertilizer, *etc.* Upland cotton seeds usually contains between 0.6 to 2.0 % gossypol<sup>22</sup>.

Malek and Zandi<sup>23</sup>, determined free gossypol level in 11 varieties of cotton seed cultivated in Iran for normal glanded cotton seed samples was 1.14 %, for native variety 0.53 % and for hybridized variety 0.11 %. Also, no gossypol detected in the glandless cotton seed variety. Bertrand *et al.*<sup>17</sup> reported that the gossypol level of WCS was 0.66 %.

In this study, total gossypol ranged from 0.51 to 1.45 % in all varieties. Similarly, Calhoun *et al.*<sup>24</sup> reported that total gossypol in commercial upland whole seed ranged from 0.52 to 1.01 % in 24 varieties. Santos *et al.*<sup>25</sup> determined the total gossypol content of cracked Pima and whole upland cottonseed as 1.03 and 0.69 % respectively, on as is basis.

Total gossypol levels was determined as 0.591 % in expeller CSM's and 0.574 in solvent CSM, while free gossypol levels were determined as 0.06 % for the former one and 0.058 % for the latter one.

TABLE-4  
TOTAL AND FREE GOSSYPOL LEVEL OF COTTON SEED MEAL

Variety	Total gossypol		Free gossypol	
	ppm	%	ppm	%
Expeller	5914	0.591	604	0.060
Solvent extraction	5744	0.574	579	0.058

Different extraction techniques most likely have considerable effect on the amount of free gossypol in CSM's. Zin *et al.*<sup>26</sup> reported that free gossypol level 0.06 % for solvent extraction CSM. Malek and Zandi<sup>23</sup> also reported the free gossypol of CSM in Iran ranged from 0.026-0.16 %.

The reason of the similar free gossypol content of our and those in different countries more likely is to the genetic improvement in obtaining the lower level of free gossypol contained cotton hybrid.

In conclusion, Nutrition and gossypol level show that whole cotton seed (WCS) and cotton seed meal (CSM) can be used in farm animal nutrition safely since the gossypol content of these agricultural by-products are inline with standards in the reference books and Turkish Agriculture Ministry.

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