

UPGRADE OF SUNFLOWER MEAL PROCESSING TECHNOLOGY

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SUMMARY

The objective of this paper is to investigate sunflower meal processing technology which enables adequate breaking up of the conglomerates, *i.e.*, detaching of the protein core from the adhered hull and allowing for the hull separation by mechanical fractionation. Sunflower meal from the regular production of a domestic oil extraction plant, of the standard, pre-determined quality, with lower (sample 1) and higher (sample 2) percentage of conglomerates was used as a starting research material. Roll crusher was used for breaking up of the conglomerates. Particles larger than 5.0 mm were almost completely crushed in both samples, whereas percentage of particles larger than 2.0 mm was reduced by 17.6% in sample 1 and by 36.9% in sample 2. At the same time, percentage of particles smaller than 1.0 mm was increased by 6.9% in sample 1 and by 23.3% in sample 2, indicating that crushing of larger particles is more intense in both samples. Fractionation process on centrifugal separator results in the increased yield of high-protein sunflower meal (passing through the sieve) from 31.72 to 59.33%, while crude protein is reduced only from 0.25 to 0.68% of absolute value. As a result, obtained products passing through the sieve mesh size 1.5 and 1.8 mm are within the limits prescribed for the high quality sunflower meal. Preliminary treating by roll crusher upgrade the sunflower meal processing technology by increasing the yield of high protein sunflower meal and allow better valorisation of this feed.

Key words: crusher, hull, separation, sunflower meal, technology

INTRODUCTION

Sunflower meal consists of the remainders of sunflower kernel and seed hull and is a by-product of the oil extraction process. Sunflower hull reduces nutritional value of the protein from the kernel (Ravindran, 1992; Salab, 1999; Senkoylu, 1999; Zhang, 1994). Physical properties of sunflower meal closely related to the hull content, such as non-uniform particle size and particle size distribution, low

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bulk density, dusting, segregation tendency, are not desirable in the animal feed production (transport, storage, mixing, pelleting...), because they adversely affect its nutritional quality (Lević, 1992; Sredanović, 2005; Sredanović, 2007). Numerous research results (Delić, 1992; Lević, 1998; Montagne, 2003; Moughan, 2000) clearly indicate that hull content in the sunflower meal should be reduced to minimum and that high protein types of this feed may successfully replace other protein sources and be used in the nutrition of younger and more sensitive categories of animals.

Sunflower meal fractionation on centrifugal separators, as de-hulling process, has been used by the edible oil industry in Serbia for decades. According to original solution developed in then Department of Feed Technology at the Yugoslav Food Institute in Novi Sad, about 55-60 kg of sunflower meal with crude protein content of 44-45% and crude fibre content of 8-10% could be obtained from 100 kg sunflower meal with crude protein content of 37-38% (Delić, 1971). However, following the introduction of the small seed sunflower lines, with larger percentage of **hulls** remaining more firmly **attached to the kernel**, it was not possible to achieve such good results in terms of quality and yield. Results of later research work (Lević, 1989) show that as a result of centrifugal separation on the sieve with mesh size 1.5 mm, 43.3 kg sunflower meal with crude protein content of 43.8% and crude fibre content of 12.5% may be obtained from the initial 100 kg sunflower meal with crude protein content of 37.5%, or, in other words, that only 50.6% of crude protein from the initial quantity is separated into protein fraction of sunflower meal. As sunflower meal is one of the most important sources of valuable proteins in our country, sunflower meal processing technology must be upgraded to enhance the yield of fractions with better quality.

Separation of sunflower hull from the kernel by means of mechanical fractionation on the centrifugal separators is hindered due to presence of firm conglomerates adhering to the hull. Significant amount of these conglomerates is retained on the sieve and separated together with the hull as a fraction of poorer quality (Delić, 1992; Lević, 1992). To separate adherent particles, conglomerates need to be disintegrated, but, at the same time, excessive break-up of the hull is to be avoided (Sredanović, 2007; Lević, 2009) or, otherwise, the quality of the sunflower meal will be compromised (reduced crude protein content and increased crude fibre content).

The objective of this paper is to investigate sunflower meal processing technologies enabling adequate breaking up of the conglomerates *i.e.*, separation of the protein core from the adherent hull and allowing for hull separation by centrifugal fractionation. Sunflower meal processing technologies and fractionation procedures should enable production of larger quantities of high protein sunflower meal in order to expand its usage in animal feed industry and increase converting efficiency from feed into meat and other food products.

MATERIALS AND METHODS

Sunflower meal from the regular production of a domestic oil extraction plant, of the standard, pre-determined quality, with lower (sample 1) and higher (sample 2) percentage of conglomerates was used as a starting research material. These starting samples of the sunflower meal were analyzed for crude protein and crude fibre content and particle size distribution, and subjected to centrifugal separation, with or without pre-crushing.

The aim was to determine improvements in yield and/or quality of high-protein fraction of sunflower meal characterized by the increased crude protein content and decreased crude fibre content.

Roll crusher (pair of corrugated rollers: length 500 mm, distance between the rollers 5.0 mm, motor power 5 kW) was used for breaking up of the conglomerates. Crushing efficiency was evaluated by comparing particle size and particle size distribution before and after the crushing treatment, namely, particle-size analysis was carried out before and after the treatment. Crushed material was packed in bags and weighed to avoid batch-to-batch residues and losses in the production line and was subjected to fractionation later.

Semi industrial centrifugal separator (type 218-SS-I manufacturer „Zmaj“, Serbia, motor power 5.5 kW, 1435 rev.min⁻¹, sieve surface 0.6 m² and mesh openings size ϕ 1.5; 1.8 and 2.0 mm) was used for fractioning. Sunflower meal feeding rate into the centrifugal separator was adjusted at 300 kg h⁻¹. Fractionation efficiency was evaluated by measuring fraction yield and determining crude protein and crude fibre content in the obtained products, that is, particles passing through the sieve represent high protein fraction, while particles retained by the sieve represent cellulose fraction.

During the treatment the samples were taken of starting sunflower meal, crushed sunflower meal, as well as of the particles passed through the sieve and those retained by the sieve after fractionation, with and without crushing. For crude protein and crude fibre analyses, ten average samples were taken. Particle size analysis was conducted in the samples taken before and after crushing.

Crude protein and crude fibre contents were determined with AOAC methods (AOAC, 1984). Particle-size analysis was carried out according to ISO 2591-1: 1988 E methods (ISO, 1988).

RESULTS AND DISCUSSION

The starting samples had approximately equal crude protein and crude fibre content. Crude protein and crude fibre content in the sample 1 was 38.7% and 18.9%, and 38.5% and 19.4% in sample 2, respectively.

Taking into account that the particle size and distribution has a considerable effect on the fractionation efficiency (Lević, 1989; Sredanović, 2007) sieve analysis

was conducted on both uncrushed and crushed samples. Two uncrushed (starting) samples with different particle size and particle size distribution, *i.e.*, different percentage and size of conglomerates were analyzed. Mean values of obtained results are shown in Figure 1.

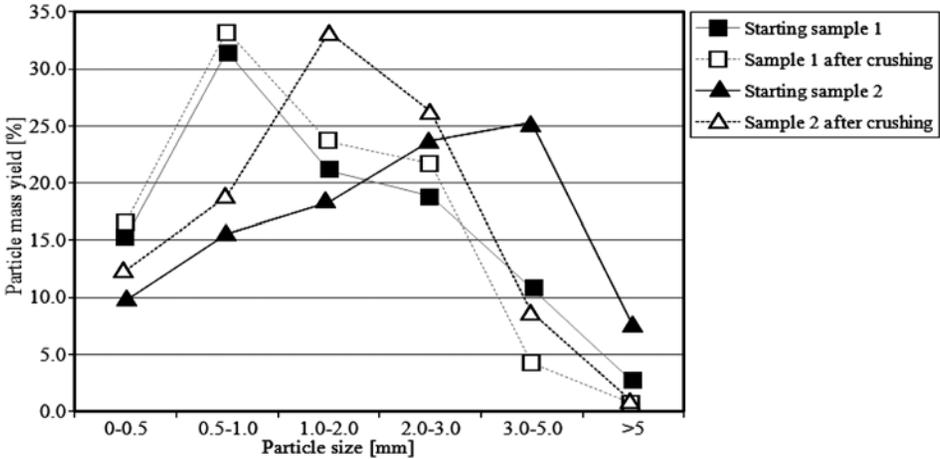


Figure 1. Particle size distribution of tested sunflower meal samples before and after crushing

Starting sample 2 had significantly greater percentage of conglomerates. After crushing, particles larger than 5.0 mm were almost completely crushed in both samples, whereas percentage of particles larger than 2.0 mm was reduced by 17.6% in sample 1 and by 36.9% in sample 2. At the same time, percentage of particles smaller than 1.0 mm was increased by 6.9% in sample 1 and by 23.3% in sample 2, indicating that crushing of larger particles was more intense in both samples.

Table 1: Average fraction yield, crude protein and crude fiber content in the particles that passed through the sieve after centrifugal separation of the sunflower meal, crushed and uncrushed

| Item [%] | Sample 1 | | | Sample 2 | | |
|---|---------------------------|------------|------------|---------------------------|------------|------------|
| | Sieve opening ϕ [mm] | | | Sieve opening ϕ [mm] | | |
| | 1.5 | 1.8 | 2.0 | 1.5 | 1.8 | 2.0 |
| Through without pre-crushing | 44.81±1.31 | 48.72±1.30 | 54.63±0.96 | 31.72±0.38 | 35.18±1.24 | 41.74±1.13 |
| Through after pre-crushing | 49.22±1.22 | 53.44±2.51 | 59.87±1.63 | 43.75±0.98 | 49.26±1.38 | 56.33±2.07 |
| Crude protein in through without pre-crushing | 43.37±1.32 | 42.82±1.17 | 42.06±0.87 | 42.91±0.65 | 42.64±0.43 | 40.67±1.02 |
| Crude protein in through after pre-crushing | 42.91±0.70 | 42.14±1.37 | 41.15±1.52 | 42.66±0.85 | 42.14±0.94 | 40.12±1.14 |
| Crude fiber in through without pre-crushing | 10.83±0.12 | 11.13±0.24 | 12.61±0.35 | 10.91±0.10 | 11.24±0.08 | 12.92±0.14 |
| Crude fiber in through after pre-crushing | 11.00±0.06 | 11.42±0.11 | 12.93±0.21 | 11.34±0.06 | 11.82±0.16 | 13.61±0.09 |

Results of sunflower meal fractionation process on centrifugal separator with the mesh opening size: ϕ 1.5, 1.8 and 2.0 mm, with and without pre-crushing, are given in Table 1.

It is evident that the process of centrifugal separation on the sieves with mesh opening size 1.5 and 1.8 with pre-crushing, provides increased percent of high protein sunflower meal of first quality, containing more than 42.0% of crude protein and less than 12.0% crude fibre (Pravilnik, 2010). Pre-crushing sunflower meal treatment increased percent of passing through the sieves by 14.3 - 15.1% for sample 1, by 53.7 to 59.0% for sample 2 and reduces crude protein content by less than 1.0% in absolute value for all samples. Crude fibre content (10.83 to 13.61%) in the materials passing through the sieves after crushing and fractioning and the difference of only 0.17 to 0.69% of absolute value in crude fibre content compared to samples not treated by roll crusher is an indication that excessive crushing of the sunflower did not take place during the process.

Upgraded technology for sunflower meal production by using pre-crusher treatment enabled distribution of 54.02-66.76% crude proteins from the starting sample into the high protein sunflower meal fraction. That means 12.44-13.08% more crude protein in passing through the sieves after crushing and fractioning in sample 1 and 47.72-55.05% in sample 2 compared to same non treated samples. These upgraded decellulosed sunflower meals represent highly valuable sustainable products suitable for feeding young and sensitive animals.

CONCLUSION

Based on the obtained results, it can be concluded that the yield of high-protein sunflower meal is enhanced when it is crushed on roll crushers before fractionation. Roll crusher treatment and later centrifugal separation on different sieves (mesh openings size ϕ 1.5; 1.8 and 2.0 mm) enable the yield of 48.75-59.33% of sunflower meal fractions with high protein (40.12-43.37%) and low fibre content (10.83-13.61%).

After treatment on the roll crushers, percent of the particles passing through the sieve is increased by 14.3.0 to 59.0%, while crude protein is reduced by less than 1.0% in absolute value. As a result obtained products passing through the sieve mesh size 1.5 and 1.8 mm are within the limits prescribed for sunflower meal of the first quality.

Upgraded technology for sunflower meal production by using pre-crusher treatment gives higher yield of high protein sunflower meal (up to 15.08% for sample 1 and up to 59.03 for sample 2). It can be noticed that increase was significantly greater for sample 2 which had had more conglomerates at the beginning.

Obtained results may significantly upgrade sunflower meal processing technology, enhance its nutritional value and, subsequently, improve and increase production of high-protein sunflower feed. Considering the importance of the protein feed

in the animal nutrition and the level of sunflower and edible oil production in our country, the obtained results are even more significant.

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ADELANTO DEL PROCEDIMIENTO TECNOLÓGICO DE ACABADO DE LA HARINA DE ACEITE DE SEMILLA DE GIRASOL

RESUMEN

El objetivo de la investigación fue investigar las posibilidades de encontrar un procedimiento tecnológico adecuado de acabado de la harina de aceite de semilla de girasol, que posibilite romper bultos, es decir, liberar el núcleo proteínico de la cáscara pegada, con la condición de que la cáscara no se haga demasiado menuda, para que pueda separarse por el fraccionamiento mecánico. El material inicial para las investigaciones fue la harina de aceite de semilla de girasol de la producción regular de una planta aceitera, de calidad habitual, determinada con antelación, con mayor (muestra 1) y menor (muestra 2) contenido de bultos. Por acabado en la trituradora con cilindros, en ambas muestras investigadas, casi en totalidad, las partículas menudeadas fueron mayores de 5.0 mm, y la participación de las partículas mayores de 2.0 mm, fue disminuida por 17.6% en la muestra 1, y por 36.9% en la muestra 2. Al mismo tiempo, la participación de las partículas menores de 1.0 mm, fue aumentada por 6.9% en la muestra 1, y por 23.3% en la muestra 2, lo que demuestra que este dispositivo menudeaba más intensamente las partículas de mayor tamaño, en ambos materiales investigados. Este proceso posibilita que en la continuación del proceso de procesamiento por fraccionamiento, en el separador centrífugo, se obtenga por 31.72 hasta 59.33% mayor rendimiento de la harina de aceite de semilla de girasol (la caída) de alto porcentaje de proteínas con disminución de la harina de aceite de semilla de girasol, con disminución del nivel de las proteínas crudas de sólo 0.25 hasta 0.68% del valor absoluto y que las caídas del separador centrífugo con tamices de diámetro de la apertura de 1.5 y 1.8 mm se queden dentro de los límites prescritos para la primera calidad de la harina de aceite de semilla de girasol. Aplicando la trituradora con cilindros, se adelanta el procedimiento tecnológico de procesamiento de la harina de aceite de semilla de girasol, y se obtiene mayor rendimiento de fracción de alto contenido de proteína, lo que contribuye a una mejor valorización de este nutriente.

PROMOTION DU PROCÉDÉ TECHNOLOGIQUE DE FABRICATION DU TOURTEAU DE TOURNESOL

RÉSUMÉ

Le but de la recherche a été d'analyser la possibilité de trouver un adéquat procédé technologique de fabrication du tourteau de tournesol qui permettra de briser les grumeaux, notamment de séparer le noyau protéique de la membrane collée, à condition de ne pas trop émietter la membrane afin qu'elle soit enlevée par le fractionnement mécanique. Le matériel de recherche a été présenté par des tourteaux de tournesol issus de la production régulière d'une huilerie locale, dont la qualité conforme à la norme d'une quantité de grumeaux plus élevée (échantillon 1) et moins élevée (échantillon 2). Par le concasseur à cylindres les particules plus grandes de 5.0 mm concernant l'échantillon sont presque complètement émietées, tandis que une partie de particules plus grandes de 2.0 mm est réduite à 17.6% pour l'échantillon 1 et à 36.9% pour l'échantillon 2. En même temps la partie de particules plus

petites de 1.0 mm est augmentée de 6.9% pour l'échantillon 1 et de 23.3% pour l'échantillon 2, ce qui prouve que l'appareil a concassé plus intensivement les particules plus grandes pour les deux échantillons. Ce procédé permet d'obtenir de meilleures valeurs protéiques du tourteau de tournesol de 31.72 à 59.33% dans le processus de fractionnement par le séparateur centrifuge d'une diminution de protéines crues seulement de 0.25 à 0.68% de valeur absolue et les tourteaux avec le séparateur centrifuge d'un tamis dont l'ouverture est de diamètre de 1.5 et 1.8 mm restent dans les normes de la première qualité de tourteau de tournesol. La mise en œuvre du concasseur à cylindres représente une promotion du procédé technologique de fabrication du tourteau de tournesol afin d'obtenir la meilleure valorisation de ces fractions protéiques.