

Confectionery products (halva type) obtained from sunflower: production technology and quality alterations.

A review

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Sunflower “halva” is a popular and widely enjoyed confectionery product specific to the countries of Eastern Europe. Conventional halva has historically been produced from sesame seeds in the Middle East and Northern Africa. However, in the production of halva in Eastern Europe, sesame seeds have been largely replaced by sunflower seeds, due to the high availability of sunflower in this region and the comparable taste of the final product. Due to the importance of the cost of raw materials in the food industry, utilization of sunflower seeds in halva production may be of great interest worldwide because it offers the possibility of significantly lowering production costs. Nevertheless, oil separation and storage techniques must be perfected if sunflower halva is to fulfill its promise of becoming a cost effective alternative to sesame seed halva on a worldwide scale. The aims of this review are firstly, to describe the current state of sunflower halva technology, secondly, to isolate the main problems affecting the quality of the final product, and thirdly, to suggest areas of further research necessary to move sunflower halva production closer to reaching its full potential on the world market.

Keywords. *Helianthus annuus*, sunflower seed, sugar confectionery, oxidation, sesame.

Les produits de confiserie (type halva) obtenus à partir du tournesol : technologie de production et problèmes de qualité (synthèse bibliographique). Le « halva » de tournesol est un produit de confiserie populaire et apprécié dans les pays d'Europe de l'Est. Depuis des années, dans cette région, les graines de sésame utilisées pour la fabrication du halva classique préparé dans de nombreux pays du Moyen-Orient et d'Afrique du Nord ont été remplacées par des graines de tournesol qui conduisent à un produit final de gout comparable ; ce fait est également accentué par la grande disponibilité du tournesol dans cette zone. Considérant l'importance du prix des matières premières dans l'industrie alimentaire, l'utilisation de tournesol dans la production de halva pourrait être d'un grand intérêt à l'échelle mondiale, visant des couts de production moins élevés. L'amélioration de la qualité du halva de tournesol devrait également concourir à ces perspectives prometteuses. Ainsi, le but de cet article de synthèse est de décrire l'état de l'art de la technologie du halva de tournesol en mettant l'accent sur les principaux problèmes qui peuvent affecter la qualité du produit final, à savoir la séparation de l'huile et le rancissement pendant l'entreposage.

Mots-clés. *Helianthus annuus*, graine de tournesol, produit de confiserie, oxydation, sésame.

1. INTRODUCTION

Sunflower is an oilseed crop native to North America (~ 3,000 BC) which was introduced into Europe by the Spanish in the early 1500s (Gulya, 2004). According to FAO 2012 statistics, Europe now consumes more than two thirds of total world sunflower seed production. Expanding the market for sunflower seed oil would

provide a boost for Eastern European agriculture. Moreover products using sunflower seeds as their raw material are characterized by a balanced nutritional composition (Damir, 1984; Damir et al., 1990). However, among oil crops worldwide, sunflower seed ranks seventh behind soybean, palm, coconut, rapeseed, cottonseed and peanuts (FAO, 2012). This makes increasing sunflower seed exports a difficult prospect

economically, because the relative demand outside Europe is low. One way to expand the sunflower seed market and to increase the demand is to improve the quality of value-added sunflower products, including halva. Currently issues with oil separation and rancidity during storage provide the main obstacles preventing the worldwide prevalence of sunflower seed halva production. The aims of this review are firstly, to describe the current state of sunflower halva technology, secondly, to isolate the main problems affecting the quality of the final product, and thirdly, to suggest areas of further research necessary to move sunflower halva production closer to reaching its full potential on the world market.

2. HISTORY AND ORIGINS OF CONFECTIONERY HALVA TYPE PRODUCTS

It is very probable that before the chocolate candy boom in the late 1800's, the most popular confection in the world was Halva (modern English spelling), *halava* (Sanskrit transliteration), *halvah* (Hebrew transliteration), *halawi* (Arabic transliteration), *helva* (Turkish transliteration) or *halwa* (alternate Hindi transliteration). Tannahill (1988) and Davidson (2002; 2006) consider it to have Arabic roots, the name "halva" coming from "hulw", the Arabic term for "sweet". However, Davidson (2006) noted halvahs Indian roots. In the northern part of India it has given its name to the caste of confectioners – "the halvais". The same author noted also that in 7th century in Arabia, halva meant a "paste of dates kneaded with milk", while by the 9th century halva was more or less a stiff paste prepared from toasted or fried semolina or wheat flour mixed gently at heat together with a sweetening agent such as sugar syrup, date syrup, grape syrup, or honey. Usually a flavoring was added such as nuts, rosewater, or pureed cooked carrots. The first known written halva recipe appeared in the early 13th century Arabic Kitab al-Tabikh [The Book of Dishes], and included seven variations. A cookbook from Moorish Spain in the same period describes a type of product made from a candy sheet (boiled sugar, honey, sesame oil and flour), sprinkled with rosewater, sugar and ground pistachios, and covered with a second layer of candy before cutting it into triangles.

Halva spread worldwide, being produced with a wide variety of ingredients, methods, and flavorings. In the Middle East, semolina-based halva is the usual type, and is modified by the addition of nuts, dried fruits, coconut, yoghurt, honey, and spices. However, Turkey and Greece produce halva types without grain and instead derive their texture from the combination of cooked egg and solidified syrup. Whole, chopped or milled nuts are included in all halva recipes. Sometimes

they contain also dried or candied fruits. The halva best known in Europe and North America is another non-grain type, sesame halva (Davidson, 2006).

Since many countries, from the Balkans to India, lay claim to the idea of mixing nut-paste with a sweetening agent and possible egg whites or soapwort extract, it becomes impossible to discern where halva was created.

3. PROCESS OPERATIONS, TECHNICAL MEANS AND TECHNOLOGICAL PARAMETERS IN CONFECTIONERY SUNFLOWER HALVA TYPE PRODUCTS MANUFACTURING

Sunflower halva became characteristic to Eastern European countries due to sunflower seeds great availability in this region, coupled with the fact that sunflower seeds are highly appreciated by Eastern European consumers (Racolța et al., 2010; Mureșan et al., 2010).

Kahraman et al. (2010) mentioned that the volume of sesame halva production is in the range of 35,000 to 40,000 t *per annum* in Turkey. In Romania, annual halva production is in the range of 1,500 to 2,000 t, most of this being sunflower based (Racolța et al., 2010). Sunflower halva is made of sunflower tahini instead of sesame tahini. Although sunflower halva is a known and appreciated product in Eastern European countries, limited publications are available on this subject (Nikiforova et al., 1983; Damir, 1984; Damir et al., 1990; Mureșan et al., 2010; Racolța et al., 2010). The same holds true for similar sunflower based confectionery products (MacDonald et al., 1985; Keshashyan et al., 1989; Ikhno et al., 1990; Kang, 2006).

The manufacturing process for sunflower halva type products is presented in **figure 1** and consists of the following main stages (**Table 1**):

- cleaning and sorting sunflower seeds;
- tahini preparation;
- soapwort (*Saponaria officinalis*) extract and cooked sugar preparation;
- halva mass preparation;
- processing of halva mass.

4. QUALITY PROBLEMS OF CONFECTIONERY HALVA TYPE AND SIMILAR PRODUCTS

After scrutinizing the manufacturing process of sunflower halva type products and consulting with authorities in the Romanian halva industry, the following main problems severely affecting final

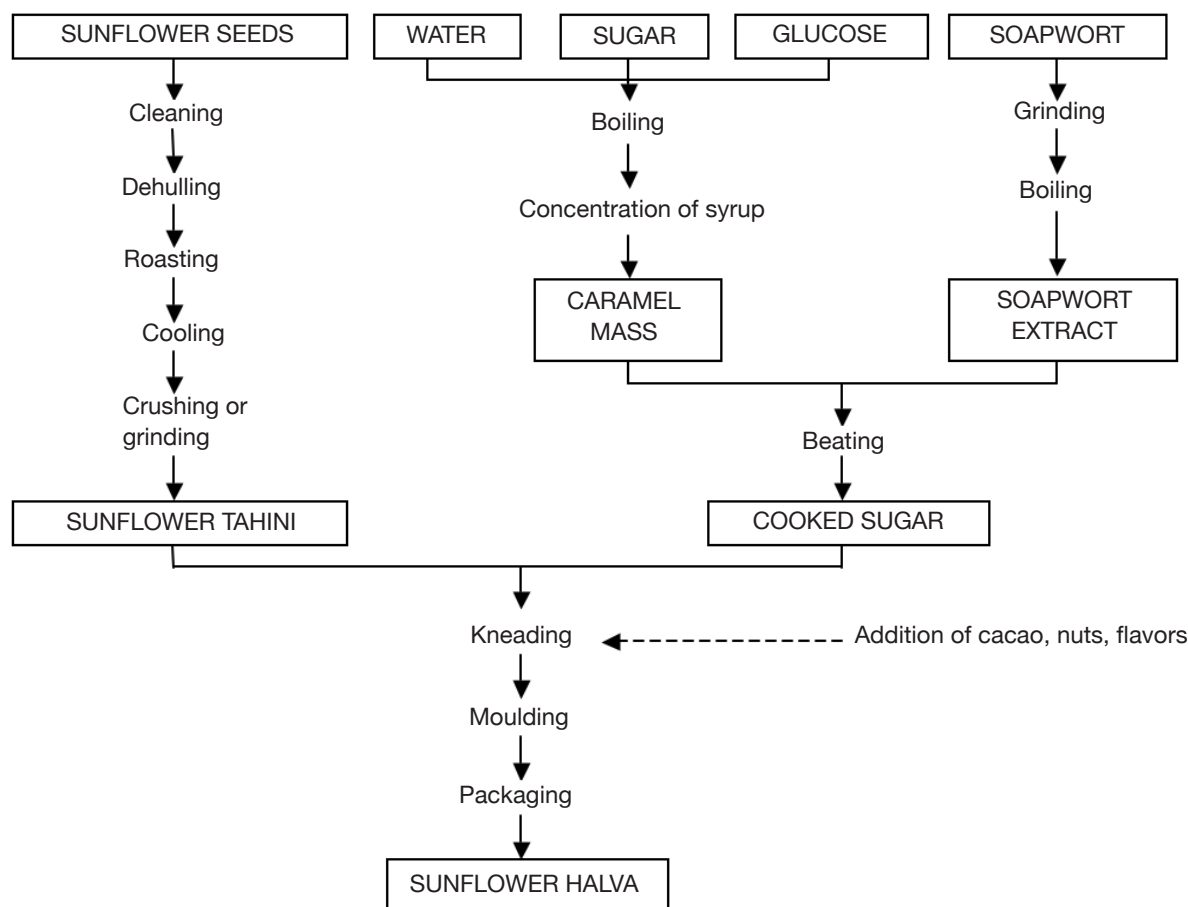


Figure 1. Technological flow chart for sunflower halva — *Diagramme de flux technologique pour le halva de tournesol* (Racolța, 2008).

product quality were identified (linked issues are also highlighted in **table 1**):

- oil separation;
- rancidity during storage.

Solving these two limiting factors will be imperative if sunflower halva production is to expand to become a viable world export. Unfortunately, limited information are found in literature regarding sunflower halva quality (Damir, 1984; Damir et al., 1990; Mureșan et al., 2010; Racolța et al., 2010). Nevertheless, similar better-known worldwide products, such as sesame tahini and sunflower peanut butter, have been studied to a greater degree, and an analysis of these products can provide valuable insight into improving techniques for sunflower halva production. The following two sub-chapters will mainly focus on oil separation and storage of halva type and similar products.

4.1. Oil separation problem of confectionery halva type and similar products

Damir (1984), when studying the oil separation problem in sesame and sunflower tahini-like butter,

reported that the separation occurred 3 to 6 days after preparation; the amount of oil separated reached 7.6% (sesame tahini), 11.8% (sunflower tahini-like butter) and 6.25% (sunflower tahini containing 1% glycerol monostearate), respectively, after 90 days of storage. The same author concluded that the addition of glycerol monostearate to sunflower tahini-like butter had a pronounced stabilizing action, reducing the oil separation in comparison with the untreated tahini.

In another study, Damir et al. (1990) emphasized the importance of oil separation from tahini and halva, considering it a serious defect, due to the troubles caused in handling and storage, and the loss entailed. They showed firstly, that sunflower halva was less stable than sesame halva and secondly, the addition of 1% glycerol monostearate had a positive effect in stabilizing tahini and halva type products; the oil separated after 90 days storage at room temperature was 6.2% for sunflower halva, 4.1% for sesame halva, 4.3% for sesame/sunflower (1:1) halva, and 3.1% for sunflower halva containing 1% glycerol monostearate.

To prevent oil separation of sunflower butter spread products MacDonald et al. (1985) included 2-4% hydrogenated vegetable oil in all three formulations

Table 1. Process operations, technical means and technological regimes in confectionery sunflower halva type products manufacturing — *Étapes du processus, moyens techniques et régimes technologiques pour la fabrication de produits de confiserie de type halva de tournesol.*

Process operation	Importance / characteristics of process operation	Technical means	Technological regimes / parameters
I. Cleaning and sorting sunflower seeds			
Pre-cleaning of sunflower seeds	Impurities removal from bulk seeds; preparation for storage	Double sieve; drum sieve; vibro-separator with air-recycling aspirator	Impurities rest in bulk seeds: 0.7 – 1.2%
Sorting / calibration of seeds	Separation of large seeds that are easily de-hulled, from small seeds, where the hulls adhere to the kernels and are difficult to remove	Double sieve; drum sieve	
Advanced sorting of sunflower seeds ¹	Separation of a relatively low percentage of high quality seeds for ease of dehulling	Double sieve; centrifugal sieve	Separated fraction: max. 10%
Final cleaning of the bulk seeds	Impurities removal; separation of metal origin impurities; preparation for tahini fabrication	Vibro-separator with air-recycling aspirator; electromagnet	Impurities rest in bulk seeds ~ 0.3%
II. Tahini preparation			
Dehulling	Removing the hulls from the kernels; hulls separation	Desheiling machine; plansifter and pneumatic separator	Hulls rest in separated kernels: 2-8%; kernel losses in hulls: 1.6%
Sunflower kernels washing	Increasing the degree of kernels bulk purity; kernels separation by floating	Batch washers; continuously operated washers	Hulls rest in bulk kernels: max. 3%
Sunflower kernels drying	Removing excess moisture for ease of roasting operation	Drum sieve; hot air dryer in fluidized bed	Initial moisture: 40-60%; final moisture: 28-30%
Sunflower kernels roasting	Moisture reduction; physicochemical and biochemical changes in kernel; changes in taste, odor and color	Bed type roasting equipment; drum type roasting equipment; roasting equipment with ceramic radiant; continuous special vacuum autoclaving system ²	Moisture reduction to 1-2%; final product temperature: 90-120 °C
Sunflower kernels cooling	Stopping the changes that occur in the kernels at high temperatures thus, avoiding that kernels become brittle, dark, or bitter	Air conditioning cooling devices; open screw conveyers	Product moisture: 0.5-2%; initial temperature 90-120 °C; final temperature 40-60 °C.
Roasted sunflower kernels milling	Breaking cell walls and oil release	Stone mills; ball mills; colloidal mills; rollers mills; 3-5 rolls refiners	Tahini temperature: 35-65 °C; empirical selection of “optimal” milling degree; no information concerning particle size or rheological properties

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Table 1 (continued 1). Process operations, technical means and technological regimes in confectionery sunflower halva type products manufacturing — *Étapes du processus, moyens techniques et régimes technologiques pour la fabrication de produits de type halva de tournesol.*

Process operation	Importance / characteristics of process operation	Technical means	Technological regimes / parameters
II. Tahini preparation (continued)			
Filtration	Retention of any remaining hulls	Drum sieve for tahini	Hulls rest: max. 0.3%; tahini temperature: 35-65 °C; tahini moisture 0.5-2%
Beating; conching; sunflower paste homogenization	Increasing dispersion degree of tahini	Beating tahini equipment; conche with those of chocolate manufacturing; equipment with double jacket for heating/cooling, with agitator	Tahini temperature: 45-65 °C; tahini moisture: 0.5-2%; tahini fat content: 55-65%
III. Soapwort (<i>Saponaria officinalis</i>) extract and cooked sugar preparation			
Grinding dry soapwort roots	Ease of washing and extracting the active substance	Manual; roll toothed crushers; hammer mills	Size: max. 40 mm
Washing. Water decanting	Removing mineral deposits and the water used for wash-rinse	Washing vessels; sieves	Water temperature: 50-60 °C; soaking time: 10-20 h
Obtaining aqueous extract	Extraction of active substance by boiling in water	Double jacket equipment for heating with agitator	Final density: $\rho = 1.05 \text{ kg}\cdot\text{dm}^{-3}$
Filtering-cooling	Removal of impurities; prevent degradation	Filters with metal sieves; cooling vessels	Cooling temperatures: 25-30 °C
Preparation of sugar and glucose syrup	Sugar solubilisation; syrup pre-concentration	Double jacket equipment for heating with agitator	Syrup dry matter: 85%
Obtaining caramel mass	Syrup concentration	Vacuum cooking apparatus	Final dry matter: 95%; reducing substances: 32-34%
Obtaining cooked sugar	Caramel mass beating; caramel mass and soapwort extract homogenization; solution concentration	Caramel mass beating machine	Density of cooked sugar: $1.1 \text{ kg}\cdot\text{dm}^{-3}$; soapwort extract: max. 2%; cooked sugar temperature: 70-80 °C
IV. Halva mass preparation			
Components mixing	Cooked sugar and tahini homogenization; mixing of optional ingredients: cocoa, whole nuts, dried fruits	Special vessels	Cooked sugar / tahini ratio: 4:6; T tahini: 35-40 °C; T cooked sugar: 70-80 °C
Kneading	Advanced homogenization of the halva mass; formation of thread like structure	Manually: special vessels; mechanically: apparatus for continuously producing laminated confectioneries ³	1 st phase: 1-2 min and working temperature: 75-80 °C; 2 nd phase: 2-3 min, temperature of 50-70 °C; 3 rd phase: 5-6 min, temperature of 40-50 °C

Table 1 (continued 2). Process operations, technical means and technological regimes in confectionery sunflower halva type products manufacturing — *Étapes du processus, moyens techniques et régimes technologiques pour la fabrication de produits de confiserie de type halva de tournesol.*

Process operation	Importance / characteristics of process operation	Technical means	Technological regimes / parameters
V. Processing of halva mass			
Molding kneaded mass	Molding in different shapes plastic containers; moldings in containers with perforated bottom (oil leakage)	Containers / metallic trays lined with parchment paper	Temperature: 40-60 °C
Halva mass cooling	Recovery of released oil	Slope shelves with special trays to facilitate oil drainage	Temperature of storage room: 10-12 °C; oil recovered: 3-5%; cooling time: 48-72 h
Packaging	Protection during storage – transportation.	Waxed paper; aluminum foil; waxed cartons; metallic and plastic containers	Moisture max. 4%; storage temperature: 18-20 °C

Sources: Iliescu et al., 1974; Vizireanu, 2003; Racolța, 2008; Burluc, 2009; Racolța et al., 2010; ¹Moisescu, 1995a; ²Moisescu, 1995b; ³Fleisch et al., 2009.

obtained, two of which also contained 2% of mono and diglycerides. In order to control oil migration, Lima et al. (2005) considered two stabilizers for the formulation of sunflower butters: hydrogenated palm oil and a hydrogenated blend of rapeseed/cottonseed oil (Dritex-C). They found that oil separation decreased with the amount of stabilizer added for both stabilizers, but noted that excessive stabilizer in the product results in a hard butter that is difficult to spread. When optimizing the formulation of a butter using sunflower kernel seeds partially mixed with peanuts, Teangpook et al. (2008) also included 2% distilled monoglyceride and 2% lecithin to avoid the oil separation problem.

Oil separation is not a problem that is exclusive to sunflower halva production only. Ereifej et al. (2005) mentioned that oil separation is a major problem that affects sesame halva quality upon storage, causing product toughness and improper oily packaging materials. The objective of the abovementioned study was to evaluate the effectiveness of improving halva quality by incorporating non-hydrogenated palm oil, glycerol, soy protein concentrate, gelatin, lecithin, pectin, gum Arabic, sugar powder, and calcium chloride. These additives were incorporated with the sugar solution, during cooking, and with tahini. Glycerol, lecithin, proteins, calcium chloride, and carbohydrates addition did not have any significant practical effect on controlling oil separation problem of sesame halva. However, calcium chloride slightly enhanced sesame halva stability, which may be due to calcium cross-linking with proteins (Ereifej et al., 2005). The addition of 1.0% or 2.5% of non-hydrogenated palm oil prevented oil separation from sesame halva stored at room temperature (25 °C), while this addition, as well as other additives, did not prevent the separation of halva stored at 40 °C. The same authors related the mechanism of preventing oil separation to an increase in viscosity of the oil phase caused by non-hydrogenated palm oil.

In a recent study, Gunesser et al. (2011) studied the effect of emulsifiers (Sorbitan tristearate [STS], sorbitan monopalmitate [SMP] and their combination 1:1) on oil separation and quality characteristics of sesame tahini halva during storage at three different temperatures (20 °C, 30 °C, and 40 °C). They found out that the emulsifiers did not have any effect on the physical, chemical and sensory properties of tahini halva except on its oil content, whereas storage temperature and storage time did have an effect on those properties. The STS:SMP 1:1 combination was found to be statistically more effective than SMP and STS formulations in preventing oil separation.

Peanut butter fat is typically around 80% unsaturated, being in liquid form at ambient temperature. Thus peanut butter dispersion, if allowed to stand at room temperature conditions for an extended period tends to

break down in two layers: peanut oil rising to the surface and a dry, compact layer of peanut solids settling at the bottom of the package (Aryana et al., 2003; Totlani et al., 2007). According to the same authors, the addition of stabilizers (*i.e.*, partially hydrogenated vegetable oil, mono-, di-, or tri-glycerides of vegetable oils or their combination) prevents peanut butter oil separation by crystallizing at a low temperature, allowing the development of a network structure, which immobilizes the free oil, preventing its migration. From storage studies it was found that levels higher than 1.0% were considered adequate quantities of the additive to stabilize the peanut butter samples, and the products formed a stable network structure which was capable of withstanding any major changes for three months at 35 °C (Totlani et al., 2007).

Francisco et al. (2006) recognized that the most serious problem with natural peanut butter is the tendency of the oil to separate. Thus, after testing Myvatex monoset® (a fully hydrogenated rapeseed and cottonseed oil blend, containing high erucic acid), distilled monoglyceride Type P(V)® (a fully hydrogenated vegetable oil) and, κ -carrageenan at several levels, they concluded that 1% Myvatex monoset® had the highest ability to prevent oil separation in peanut butter samples stored up to three months at room temperature. Their study also revealed that the conditioning method (48 h at 10 °C), as well as roasting time (40, 50, 60 min), had no effect on the oil separation problem. In a similar study Gills et al. (2000) concluded that palm oil could not effectively stabilize peanut butter for one year at ambient temperature. Also, the amount of oil separation increased over time in peanut butter, regardless of level of palm oil added, whereas hydrogenated vegetable oil showed no oil separation during the entire study.

4.2. Rancidity problem of confectionery halva type and similar products

Riveros et al. (2010) mentioned that both peanut butter and peanut paste (confectionery products similar to halva) have high oil content, and thus are susceptible to develop rancidity and off-flavors through lipid oxidation. Furthermore, the preservation of the chemical and sensory quality of these products is one of the main problems in halva and similar products in the industry.

In their study, Gills et al. (2000) remarked that the shelf life of peanut butter depends on the quality of the raw material and the methods used in manufacturing and storing the peanut butter. They stated that peanut butter is a semi-perishable food, not readily susceptible to spoilage because of its low moisture content. However, rancidity problems during storage may appear, and are accelerated when oil separation

occurs in the product. Oil separation is a concern in peanut butter stability when the free oil is exposed to air and light because this leads to rancidity. Oxidized flavor, used as an indicator of peanut butter shelf life was prevalent in the unstabilized product at 74 days of storage (Gills et al., 2000).

Abou-Gharbia et al. (1996) examined the effect of processing conditions, namely roasting-steaming and microwaving, on the oxidative stability of sesame paste and oil stored at two different temperatures. The oxidative stability of tahini was superior to that of the extracted sesame oil. Their study further revealed that raw sesame paste and oil are most stable, microwaved products least stable, while roasted-steamed tahini and oil possess intermediate stability.

Damir et al. (1990) determined that peroxide value of sunflower and sesame halva oil increased on prolonged storage at room temperature; sunflower halva registered slightly higher values, although both showed similar oxidation patterns. The same authors noticed that rancid taste was undetected in sunflower and sesame halva during storage for 90 days. The oxidative stability was attributed to phenolic compounds contained by sunflower and sesame respectively. Damir (1984) reported much lower oxidative stability of sunflower tahini compared with sesame tahini. The former showed a rancid taste after reaching the maximum peroxide value, while the latter showed a relatively high stability. However, the same researcher mentioned that the addition of antioxidants postponed the peroxide formation in sunflower tahini and increased its stability from 18 to 47 days. In a recent study (Mureşan et al., 2010), the peroxide value of sunflower halva, as determined by a spectrophotometric method; measured at 96.19 meq O₂·kg⁻¹ at 10 months of storage was approximately two times higher than the peroxide value of sunflower halva at 4 months of storage (46.75 meq O₂·kg⁻¹), and rancid taste was detected in the sample stored for 10 months. Kahraman et al. (2010) provided an assessment of microbiological and chemical quality of sesame halva samples obtained from producers and retailers from the Marmara region (Turkey); from 120 samples analyzed, 11 were unacceptable according to the satisfactory peroxide value limit of Turkish Food Codex.

5. CONCLUSION

Developing sunflower halva as a viable value added product for export on the world market would benefit the economies of Eastern Europe. However, two main limiting factors affecting final sunflower halva product quality were identified in this review: oil separation and rancidity during storage. For sunflower halva in particular, unfortunately, there is a limited amount

of information regarding the basic understanding of these phenomena. Therefore, the conclusions drawn in this article are, for the most part, based on research of similar products. Currently, the manufacturing process of sunflower halva is mainly handled in a traditional manner, with most of the technological regimes and parameters being established empirically. Well organized research on this product technology is necessary in order to solve the oil separation and rancidity problems identified here. Future topics of interest may include:

- assessment of different sunflower seed hybrids' proper applicability to halva production (high / medium / low fat content; fatty acids profile);
- evaluation of sunflower kernel roasting conditions;
- assessment of milling process and tahini granulometry influence;
- cooked sugar composition influence;
- assessment of different storage conditions;
- examination of new ingredients (emulsifiers, saturated fats, antioxidants, etc.) applicability and efficiency;
- development of new rapid methodologies to assess sunflower halva quality.

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