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Review Paper / Derleme Makale

Potential Risks of Mechanically Separated Poultry Meat Technology

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ABSTRACT

The consumption of boneless poultry meat has recently increased. Carcass parts, which cannot be consumed directly, consist of 40% of the whole carcass, and these parts can become reusable with the process of mechanical separation. The capacity of mechanically separated meat (MSM) varies from 55 to 80% depending on the settings of the mechanical separator and the part of the animal where the meat is provided from. This ratio cannot be ignored, yet it is necessary to analyze the side effects and unhealthy conditions emerging from this process. In this review, studies related to potential risks of the MSM technology are evaluated under the subtitles such as hygiene, microbial load problem, lipid oxidation sensitivity, the fall in the acceptability scores of the products into which it is added, high pH value and high calcium level.

Key Words: Mechanically separated poultry meat, Mechanically separated meat hygiene, Chemical compound of mechanically separated meat, Poultry meat by-products.

Mekanik Olarak Ayrılmış Kanatlı Eti Teknolojisinin Potansiyel Riskleri

ÖZET

Kemiksiz kanatlı eti tüketimi artmaktadır. Doğrudan tüketilemeyecek durumdaki karkas parçaları tüm karkasın %40'ını oluşturur ve bu parçaların yüzeyinde kalan önemli miktardaki et mekanik ayırma işlemiyle geri kazanılır. Mekanik ayrılmış etin verimi, mekanik ayırıcının ayarları ve ürünün hayvanın hangi bölgesinden elde edildiğine bağlı olarak genellikle %55'ten %80'e kadar değişiklik gösterebilir. Bu oran göz ardı edilemeyecek düzeydedir. Fakat bu işlemin ortaya çıkardığı olumsuz yönleri ve sağlığa aykırı durumları da iyi analiz etmek gerekir. Bu fikirden yola çıkarak, mekanik olarak ayrılmış kanatlı eti teknolojisinde üzerinde durulması gereken konularla ilgili çalışmalar bu makalede derlenmiştir. Mekanik olarak ayrılmış kanatlı eti teknolojisinin potansiyel riskleri konusunda incelenen çalışmalar şu alt başlıklar halinde sunulmaktadır; hijyen ve mikrobiyolojik yük sorunu, lipid oksidasyonu duyarlılığı, katıldığı ürünlerde kabul edilebilirlik skorlarının düşmesi, yüksek pH değeri ve yüksek kalsiyum düzeyi.

Anahtar Kelimeler: Mekanik olarak ayrılmış kanatlı eti, Mekanik ayrılmış et hijyeni, Mekanik ayrılmış ette kimyasal bileşim, Kanatlı eti yan ürünleri

INTRODUCTION

As far as the nutritional necessities of the society are concerned, protein has an important place. The decrease in the production of red meat and animal protein deficiency resulting from the rise in prices have led to an increase in the production of poultry and especially in the consumption of chicken meat [1]. After the cut of chicken, approximately 40% of the meat including the one around the breast, back and neck of its carcass is left behind. In order to supply even more economical protein, recycling is done through the

processing of these parts generally by separating them from the bones mechanically. Today, being separated from the bones mechanically, thousands of tones of red and white meat are being used in the production of highly processed meat productions [2]. With high protein, this mechanically separated inexpensive high-tech meat is used in the production of the products like meatballs and burgers as well as emulsified products such as salami and sausages [3]. On the other hand, with a recent regulation on meat and meat products, adding mechanically separated meat to meat products was forbidden in our country [4]. The production of mechanically separated meat (MSM) especially in the poultry industry has been significantly practiced [5]. To explain it technically, Turkish Food Codex describes mechanically separated poultry meat in the related statement as "the product which is supplied as a result of the separation poultry carcass from the carcass parts and fleshy bones with a mechanical process which causes a change or loss in the structure of the muscle fiber of the raw poultry meat" [6].

No matter which animal product MSM is provided from, it is like dough and sensitive to decay despite its advantages. For this reason, certain regulations have brought restrictions to its uses. In the USA, it is not allowed to use MSM in baby food, pressed ham, sliced beef, hamburgers and cured pork meat. It can be used restrictedly in beef meatballs, smoked or cooked sausages, meat prepared for stew, sauces and similar products. If MSM contains 20 mg or more calcium, the level of calcium has to be labeled on the product. Also, in Denmark, it must be stated on the label of the product if MSM which is used as an additive in meat products adds to the formula of the product as more than 2%. In Australia, on the label of the product, it is stated as "eatable mechanically separated meat", and maximum calcium, moisture and minimum protein levels are written [5]. Under Brazilian laws, mechanically separated poultry meat can be used in a product only is it is at most 20% of the weight [7]. In the United States, it is obligatory to obey the following rules with regard to the preparation of mechanically separated poultry meat [8]. These rules can be summarized as:

Different kinds of poultry meat have to be processed separately. The use of equipment which is needed till the preparation of the last product, the amount of collagen material (tendon, ligament, and etc) to be removed , the amounts of nutritional elements which will reduce during the process need to be taken into consideration. The raw material which will be used may be cooled, dissolved, or heated or as a whole. Meat linked to the bones of cooled carcass should be kept in temperatures which are not higher than 4.4℃ and bones separated from flesh by hand should be processed in 72 hours after the mechanical separation, and or kept frozen. The meat on the warm body of the fresh-cut poultry and the one on the bones should either be processed mechanically in 4 hours, or kept in warehouses of 4.4℃ if it is to be processed in 72 hours, or if it's not, mechanically separated poultry meat should be used in the forms of other meat or poultry products as soon as possible or cooled down to 4.4℃ in 1 hour.

According to the regulation about mechanically separated poultry meat practiced in our country, the rules which need to be obeyed with regard to the production of mechanically separated chicken meat are stated as the following [6]:

1- In the production of MSM, skin-on-neck, legs or head of the poultry cannot be used.
2- The raw material used in the production of MSM must be kept maximum 3 days starting from the cut of the poultry.
3- Unless the mechanical separation process is done right after the separation of the flesh from the bones of the poultry, the raw material must be cooled down to 2℃ or colder or frozen at -18℃ or colder temperatures.
4- The fleshy food attained from the frozen carcass cannot be frozen again.
5- Unless MSM is to be used in the production of thermal processed meat products, it must be cooled down to 2℃ or colder temperatures.
6- If MSM is not to be processed in 24 hours, in 12 hours after the attainment it must be frozen, and in 6 hours its central temperature must be brought down to -8℃ or colder temperatures.
7- The frozen MSM must be stored or shipped as pre-packed or packed. MSM cannot be stored for more than 3 months. During storage or shipping its temperature must be at -18℃ or lower.
8- Frozen MSM cannot be frozen again after dissolved.
9- The calcium content of MSM must be maximum 0.5%.

On the other hand, with a recent regulation on meat and meat products [4], adding mechanically separated meat to meat products was forbidden. Unfortunately there is a big gap in the regulations with this new situation because MSM production is allowed but its usage in meat products is forbidden. So, what are producers suggested to do with MSM? This decision will bring some negative applications for example using MSM in catering business or in meatballs in order to reduce the costs.

MSM chemical compound of chicken depends on the source of the raw material. For example, the skin tissue increases lipid while it reduces protein [7]. In general, MSM contains more fat, moisture or mineral depending on the meat from which the raw material is supplied. However, the content of protein is lower [9].

The varieties in the compound of mechanically separated poultry meat depend on several factors. These factors are the animals' age, flesh and bone proportion, method of cut, the proportion of bone separation, skin content and denatured protein [5]. As can be seen from literature we gained, many features of mechanically separated poultry meat technology have been investigated, yet its nutritional value has not been studied about much. In one of their studies, Carolina et al. [10] state that nutritional compound of MSM is similar to the chicken meat from which it is attained, yet it has poor levels of lysine.

Another important point of mechanically separated poultry meat is the content of fatty acids and cholesterols. As a result of the fact that bone marrow is added into meat after mechanical separation, mechanically separated meat has high levels of phospholipids and cholesterol [11]. Bones processed to be separated from flesh includes 24-66% bone marrow. Some part of it is mixed with the product being grinded with mechanical separation process. This is the most important reason why mechanical separation process is more efficient than manual separation process [12]. The efficiency of MSM varies between 55% and 80% depending on the settings of the separator and the part which is separated [13]. Unfortunately, mechanical separation of poultry meat which is an economical recycling also has some drawbacks. In this study, we have gathered some negative effects concluded from scientific research on MSM.

HYGIENE AND MICROBIAL LOAD PROBLEM

The microorganism load of poultry meat which is separated mechanically is higher than meat separated manually. Depending on the type of the machine, mechanical separation process leads to an increase in the temperature between 1 and 8°C during the production. Thin fragment of MSPM and the increase in the surface depending on this, the release of the cell liquid which is rich in nutritional content during the process, the rise in the temperature, high pH value and the mixture of external tissue which is a point of microbial meeting with the clean internal tissue encourages the microbial development. Thus, the storage-life of the product is shortened [12,14,15]. Hecer and Sözen [16] applied lactic acid, acetic acid and sodium lactate to mechanically separated poultry meat in order to reduce microbiological load. As a result of their study the most effective bacterial decrease for total aerobe mezophilic bacteria counts was seen in 2% sodium lactate applied group with a ratio of nearly 15% decrease. *Escherichia coli* counts were lower for all organic acid applied samples than control groups ($P < 0.05$). It was concluded that 0.2 and 0.3% LA, 1 and 2% SL concentrated organic acid applications are the most successful applications of mechanically separated meat decontamination for both microbiological and sensorial criteria. The shelf-life of MSPM was prolonged 1 day by the experimental solutions [16].

LIPID OXIDATION SENSITIVITY

The main problem of the products produced with MSPM is the occurrence of oxidative changes resulting in a bitter taste and bad smell [17]. Multiple unsaturated fat acids of meat such as linoleic and arachidic acid are exposed to big changes during the storage by freezing. As a result, the secondary products of fat oxidation such as aldehydes, ketones, hydrocarbons, esters, furans and lactones are responsible for all the bitter taste and sensual disorders [13]. Especially high pressure during the production, contact with air, the increase in temperature and the bone marrows naturally included in the products, the extent of both pigments and unsaturated fat acids catalyze the oxidation [18]. The metal ions of separating machine and calcium and phosphor from the bone can behave as a catalyst [19]. Oxidized lipids cause the polarization of protein, insolubility, polypeptide chain separation and the catabolism of amino acids. Lipid protein interaction changes the functional characteristics of meat and may cause some unhealthy changes in the quality of the product.

Fernandez et al. [20] state that during the mechanical separation process, oxidative development of MSPM encourages the auto-oxidation of multiple unsaturated fat acids in the phospholipids which is present in the tissues of the poultry and provides the release of both pigments and oxidative enzymes in the product and their merge with oxygen. Pikul et al. [21] explain that phospholipids of the chicken meat are efficient in almost 90% of the malondialdehyde measured in the fat attained from this meat.

In MSPM samples which contain high amounts of pigments and iron have proved to possess more intensive oxidative changes [22]. Compared to manual separation, mechanical separation process of deboning triples the amount of pigments. Mechanical separation does not only release pigments and lipid components, but also these components and lipids behave as a catalyst in the auto-oxidation [23]. Gomes et al. [24] and Lai et al. [25] have also reported similar results.

REDUCED ACCEPTABILITY SCORES OF THE PRODUCTS AND RESTRICTIONS

According to a report by Kolsarıcı and Candoğan [5], if high proportion of MSM is mixed with manually separated meat, the taste and the general acceptability scores reduce and meat dough with MSM has a clearly different composition of lipids and proteins. Mechanical separation process causes the catabolism of cells, denaturation of proteins and an increase in the lipids and heme groups [26]. Moreover, MSM contains more bone marrows compared to manually separated meat. Mechanical separation generally releases the heme pigments in the bone marrows and leads to an increase in its proportions in the meat [5]. Heme pigments affect muscle lipids and may cause taste problems [19]. Besides, heme pigments catalyze lipid oxidation in the meat and result in the development of an unwanted flavour [5]. High proportions of heme pigments influence the colour of MSM and make it darker and this restricts the uses of the meat [5, 12]. The recommended proportion is around 5-20 % (generally 10%). When used in certain amounts with meat products, the dark colour and juicy consistency of MSM are usually balanced being mixed with soy protein which has a lighter colour and flexible structure [12].

HIGH pH VALUE

pH value of mechanically separated meat is very important for the functional characteristics of the products. High pH affects the colour and especially the emulsion characteristics of the meat. In the formation of the emulsion, pH has a great effect since proteins are

the least active chemicals in isoelectric pH and their solubility and capacity to keep water is the lowest [27]. Proteins easily sink in an isoelectric point [28]. The increase in the pH of MSM stems from the red bone marrow (pH 6.8-7.4) and phosphate of lime in the bone [5]. When the amount of marrow increases in the muscle, pH rises, as well. The existing muscle and marrow proportion of MSM varies considerably depending on the amount of muscle on the bone during the separation (Field, 1976 in [29]). Proteins have the least ability to keep water in the isoelectric point. When the pH increases, the capacity to keep water gets better [5]. PH is necessary to be high in the environment for the formation of stable emulsion [29].

Abdullah and Al-Najdawi [19] separated hens from their bones in 4 different methods (manual separation of the whole carcass, manual separation of the whole skinless carcass, mechanical separation of the whole carcass and mechanical separation of the whole skinless carcass) and stored the meat at -18°C for 3 months and investigated the functional characteristics like pH, the capacity of emulsion and the capacity to keep water and sensorial parameters with pigment concentration like colour, flavour, texture and acceptability. In general, high pH value in mechanically separated meat is beneficial as far as food technology is concerned, yet it is essential to be careful since it is a factor which reduces the microbial quality of the product [15].

HIGH ASH and CALCIUM LEVEL

In some countries, it is necessary to search the calcium content of the meat to define the bone particles in it. According to the regulations in the United States of America, there cannot be more bone particles than 1% in MSM. For this reason, a mechanical separator must not be set to produce a product which will include more calcium than 1% [12]. According to the regulation about mechanically separated poultry meat, the calcium content must be maximum 0.5% [6].

Ash content in mechanically separated meat is higher in comparison with the manually separated one. This amount depends on the age and type of the animal, the temperature and type of the separation from the bones. Because bone and marrow components have been mixed with the meat before mechanically separated chicken meat is sifted, ash content in it is more than the ash content in the untreated meat. The ash content of MSP is between 0.6 and 1.2°C [12]. Since older animals have tougher bones which break down more easily in the machine, the mechanical meat supplied from these contains more ash. Besides, cool-separated meat is richer in mineral than warm-separated meat, thus ash content in this meat is also higher. The amount of the ash increases in direct proportion to the efficiency of the machine. The main mineral existing in mechanically separated meat is calcium. The high proportion of calcium is important for people who have lactase deficiency and cannot digest milk. Depending on heme pigments, iron content is two or three times more in MSM than in manually separated meat. The calcium and iron existing in mechanically separated meat can easily be absorbed by the human body and these two minerals are present in higher proportions in mechanically separated meat than in the manually separated one, which is considerably important for nutrition. The level of phosphorus do not vary in big amounts between mechanically separated meat and the manually separated one, whereas other minerals like lead, fluorine and strontium 90 increases as the calcium increases. While fluoride prevents tooth decay in adults, it leads to tooth staining of young children. For this reason, in the USA, the use of mechanically separated meat in chicken and meat products is restricted with 20% and the use of mechanically separated red meat is forbidden to be used in child and baby food [3, 5, 12].

Lean meat, which is attained being separated from the bone, contains 12 mg calcium and 1.2% ash in every 100 g. On the other hand, normal meat contains 3 mg calcium and 0.2% ash in every 100 g [30]. Ang and Hamm [31] reported that the calcium content of the skinned and skinless neck and back of the mechanically separated chicken (53-91 mg/100 g) is higher than the calcium content of the skinned and skinless neck and back of the manually separated chicken (17-35 mg/100g). Abdullah and Al-Najdawive [19] investigated the calcium contents of manually or mechanically separated whole and skinned chicken meat. They have found out that the calcium content of MSPM (respectively on skinned or skinless carcass; 162.5-230.0 mg Ca/100mg) is higher than the calcium content of manually separated chicken meat (respectively on skinned or skinless carcass ; 16.75-13.50 mg Ca/100g).

REFERENCES

[1] Anonymous, (2006). Kanatlı Bilgileri Yıllığı, BESD-BBR Yayın No:7, 210 s., Ankara.
[2] Sarıçoban, C., Karakaya, M., 2005. İki farklı yöntemle kemiksizleştirilmiş piliç etlerinden üretilen sosislerin bazı kimyasal ve fiziksel özelliklerinin tespiti. *S.Ü. Ziraat Fakültesi Dergisi* 19 (35): 115-121
[3] Baker, R.C., Bruce, C.A., 1995. Further processing of poultry. In Processing of Poultry. Ed. G.C. Mead. Chapman and Hall, London.251-281.
[4] Anonymous, 2012. Türk Gıda Kodeksi Et Ve Et Ürünleri Tebliği. T.C. Resmi Gazete (5 Aralık 2012), Sayı: 28488
[5] Kolsarıcı, N., Candoğan, K., 2002. Mekanik ayrılmış etin kalite özellikleri ve kullanım alanları. *Gıda* 27(4): 277-283.
[6] Anonymous, 2008. Mekanik Olarak Ayrılmış Kanatlı Eti Tebliği. T.C. Resmi Gazete (3 Ağustos 2007), Sayı: 26602.
[7] Negrão, C.C., Mizubuti, I.Y., Morita, M.C., Colli, C., Ida, E.I., Shimokomaki, M., 2005. Biological evaluation of mechanically deboned chicken meat protein quality. *Food Chemistry* 90: 579–583.
[8] Özkeçeci, R.B., 2006. Mekanik olarak kemiklerinden ayrılmış piliç etlerinin depolama stabilitelerinin tespiti. Yüksek Lisans Tezi. Selçuk Üniversitesi, Konya.
[9] Trindade, M.A., De Felicio, P.E.,Contreras, C.J.C., 2004. Mechanically separated meat of broiler

breeder and white layer spent hens. *Scienta Agricola* 61: 234–239.

[10] Carolina, C., Negrao, C., Ivone, Y., Mizubuti, A., Morita A.C, Colli, C., Ida, E., Shimokomaki, M., 2005. Biological evaluation of mechanically deboned chicken meat protein quality. *Food Chemistry* 90: 579–583.

[11] Püssa, T. Pällin, R., Raudsepp, P., Soidla, R. and Rei, M., 2008. Inhibition of lipid oxidation and dynamics of polyphenol content in mechanically deboned meat supplemented with sea buckthorn (*Hippophae rhamnoides*) berry residues. *Food Chemistry* 107: 714–721.

[12] Ockerman, H.W., Hansen, C.L., 1999. Animal By-Product Processing & Utilization. CRC Press, 544 s., Washington DC., USA.

[13] Mielnik, M.B., Aaby, K., Rolfsen, K., Ellekjaer, M.R., Nilsson, A., 2002. Quality of comminuted sausages formulated from mechanically deboned poultry meat. *Meat Science* 61: 73-84.

[14] Yuste, J., Mor-Mur, M., Capellas, M., Guamis, B., and Pla, R., 1998. Microbiological quality of mechanically recovered poultry meat treated with high hydrostatic pressure and nisin. *Food Microbiology* 15: 407-414.

[15] Yuste, J., Pla, R., Capellas, M., and Mor-Mur, M., 2002. Application of high-pressure processing and nisin to mechanically recovered meat for microbial decontamination. *Food Control* 13: 451-455.

[16] Hecer, C., Sözen, B., 2011. Microbiological properties of mechanically deboned poultry meat that applied lactic acid, acetic acid and sodium lactate. *African Journal of Agricultural Research* 6(16): 3847-3852.

[17] Lee, T.G., Williams, S.K., Sloan, D., Littell, R., 1997. Development and evaluation of a chicken breakfast sausage manufactured with mechanically deboned chicken meat. *Poultry Science* 76: 415-421.

[18] Parry, R.T., 1995. Technological developments in pre-slaughter handling and processing. In Processing of Poultry. Ed. G.C. Mead. Chapman and Hall. 452 s. London.

[19] Abdullah, B., Al-Najdawi, R., 2005. Functional and sensory properties of chicken meat from spent-hen carcasses deboned manually or mechanically in Jordan. *International Journal of Food Science and Technology* 40: 537- 543.

[20] Fernandez, J., Perez-Alvarez, J.A., Fernandez Lopez, J.A., 1997. Thiobarbituric acid test for monitoring lipid oxidation in meat. *Food Chemistry* 59: 345-353.

[21] Pikul, J., Leszczynski, D.E., Kummerow, F.A., 1984. Relative role of phospholipids, triacylglyserols and cholesterol esters on malonaldehyde formation in fat extracted from chicken meat. *Journal of Food Science* 49: 704-708.

[22] Pikul, J., Niewiarowicz, A., 1988. Composition and stability of mechanically deboned chicken meat. *Archiv für Gehlügelkunde* 52 (5): 188-192.

[23] Froning, G.W., 1976. Mechanically deboned poultry meat. *Food Technology* 30 (9): 50-63

[24] Gomes, H.A., Silva, E.N., Cardello, H.M.A.B., Cipolli, K.M.V.A.B., 2003. Effect of gamma radiation on refrigerated mechanically deboned chicken meat quality. *Meat Science* 65: 919-926.

[25] Lai, S.M., Gray, J.I., Smith, D.M., Booren, A.M., Crackel, R.L., Buckley, D.J., 1991. Effects of oleoresin rosemary, tertiary butylhdroquinone and sodium tripolyphosphate on the development of oxidative rancidity in restructured chicken nuggets. *Journal of Food Science* 56(3): 616-620.

[26] Daros, F.G., Masson, M.L., Amico, S.C., 2005. The influence of the addition of mechanically deboned poultry meat on the rheological properties of sausage. *Journal of Food Engineering* 68: 185–189.

[27] Gökalp, Y.H., Kaya, M., Zorba, Ö., 2002. Et Ürünleri İşleme Mühendisliği, Atatürk Üniversitesi Yayınları 30-220 Erzurum.

[28] Öztan, A., 2003. Et Bilimi ve Teknolojisi. Gıda Mühendisleri Odası Yayını. 94-298 s. Ankara

[29] Field, R.A., 1976. Mechanically-deboned red meat. *Food Technology* 30 (9):38-48.

[30] Sarıçoban, C., 2004. Piliç Sosisi Üretiminde Mekanik ve Elle Ayrılmış Piliç Etlerinin Optimum Kullanım Düzeylerinin Tesbiti. Doktora Tezi. Konya.

[31] Ang, C.Y.W., Hamm, D., 1982. Proximate analyses, selected vitamins and minerals and cholesterol content of mechanically deboned and hand-deboned broiler parts. *Journal of Food Science* 47: 885-888.