Journal of Food Safety and Food Quality 74, Heft 1 (2023), Seiten 1–28

Arch Lebensmittelhyg 74,
4–10 (2023)
DOI 10.53194/0003-925X-74-4

ISSN 0003-925X

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Bacteriological enumeration, mycological profile and some physicochemical properties of Samarella (Tsamarella), a sun-dried meat product of Cyprus

Bakteriologische Auszählung, mykologisches Profil und einige physikochemische Eigenschaften von Samarella (Tsamarella), einem sonnengetrockneten Fleischprodukt aus Zypern

Halil Doruk Kaynarca[1]), Canan Hecer[2]), Beyza Hatice Ulusoy[1]), Fatma Kaya Yıldırım[1]), Hasan Anıt[1])

Summary

Dried meat products manufactured by different drying and curing methods are very common and well-known with a long history in many countries. Samarella, which is written as tsamarella in Greek, is a traditionally produced sun-dried meat product of Cyprus. To date, no microbiological survey has been conducted for this traditional product. Therefore, this study aimed to investigate the bacteriological and mycological profile of samarella. Samarella samples (n=100) were collected from various markets in Northern Cyprus and subjected to microbiological analyses for the enumeration of total mesophilic aerobe bacteria (TMAB), *Micrococcus/Staphylococcus,* lactic acid bacteria (LAB), mold/yeast and *Enterobacteriaceae*. Dry matter, pH and salt values were analyzed to determine physiochemical properties. The results from the colony isolation and numeration study revealed that, TMAB, Micrococcus/Staphylococcus, LAB, mould/yeast, Enterobacteriaceae were isolated in the range of 2.30–4.13 $\log_{10}$ cfu/g, 3.32–4.40 $\log_{10}$ cfu/g, 2.00–3.92 $\log_{10}$ cfu/g, 1.47–2.60 $\log_{10}$ cfu/g and 0–1.11 $\log_{10}$ cfu/g, respectively. Regarding the mycological analysis, 157 isolates belonging to 4 different genera of mould were isolated. The *Penicillium* genus included 65.57% of the total mould isolates and the most commonly isolated *Penicillium* species was *Penicillium nalgiovense* (30.57%). In addition, a total of 128 isolates were identified as yeast, and 3 different genera were identified. Among the yeast isolates, the genus Candida included 52.32% of the total isolates. Regarding the physiochemical properties of the sameralla samples; dry matter, pH and salt analyses results were in the range of 27.06–65.05%, 5.97–7.86 and 7.21–24.02%, respectively. Interestingly, many differences were noted between the microbiological and physiochemical properties of the varying sameralla samples, this may be due to the lack of food quality audits and the absence of standard production of samarella.

Keywords: Samarella, dried meat, physicochemical properties, microbiological profile, Cyprus

Introduction

From the past to the present, various methods have been used to preserve food for a longer period, one example has been to cure meat. Cured meat examples include biltong, jerky, cecina, pastrami, qwanta and kilishi (Temelli, 2018). Samarella (tsamarella – τσαμαρέλλα" in Greek) which is called Cypriot pastrami is also an example of a ready-to-eat type of cured meat product. Boneless goat meat is generally used in the production of samarella. Samarella was originally made from mouflon goat meat, an animal native to Cyprus. In recent years, the slaughter of mouflon goats has been prohibited and they are now a protected species. Today, samarella is produced by salting and drying sheep or goat meat. Initially, the production of samarella involves deboning goat meat. The meat is then salted and left to dry under the sun. Dried meats are soaked in hot water to remove excess salt and sliced. Thyme grown on the island of Cyprus is sprinkled on the sliced samarella to provide a unique flavor. Samarella is also a very important Cypriot meat product that is under the protection of The Slow Food Presidia project. According to Presidium rules, samarella should be produced by using only the thigh as this is the leanest, most highly valued cut and provides the earthy, rustic flavor (Slow Food Presidia, 2021). The production flow chart of samarella is presented in Figure 1.

Meat is a nutritious food item with a high nutritional profile. Due to the high amount of water and nutrients it contains it forms the appropriate medium for the growth of microorganisms, consequently meat can be spoiled easily and quickly. The microbial flora of fresh meat and microbial flora of dried meat are different from each other. Depending on the drying process, water activity (a_w) decreases. In meat products with an a_w in the range of 0.60–0.90, bacteria (e.g., *Pediococcus, Streptococcus, Lactobacillus, Staphylococcus* and *Vibrio*), moulds (e.g., *Cladosporium, Paecilomyces, Penicillium, Aspergillus, Emericella, Eremascus, Wallemia, Eurotium, Chrysosporium* and *Monas*), yeasts (e.g., *Candida, Hanseniaspora, Torulopsis, Debaryomyces* and *Saccharomyces*) take place as the dominant microbiota. Moulds, however, are the leading cause of deterioration in dried meat products. When the factors that cause mould formation in food products are examined, air exposure is the main source for mould growth. In addition to raw meat quality and storage temperatures. Production practices specify the salting and drying conditions ideal for curing meat to reduce mould growth (Huang and Nip, 2001). Nevertheless, the low pH and high salt concentrations used to cure meat moulds can still develop in dried meat products. Many studies show that the species of xerophilic *Aspergillus, Eurotium* and *Penicillium* are found in dry-cured meat products in different parts of the world (Asefa et al., 2009).

The development of some moulds in dried meat products provides specific characteristic flavors and aromas by breaking down lipids and proteins. The enzymes produced by *P. chrysogenum* and *P. nalgiovense* have been identified to contribute to lipolytic and proteolytic activities that improve aroma and meat textures. Moulds have been shown to have an antioxidant effect that can improve taste, smell and storage quality in dried meat products (Martin et al., 2006). On the other hand moulds frequently causes spoilage leading to great economic losses for producers (Samson et al., 2004). Mould and yeast contamination are often correlated with changes in meat quality and texture, smell, taste and nutritional value (Papagianni et al., 2007). Some types of spoilage moulds can produce mycotoxins, which

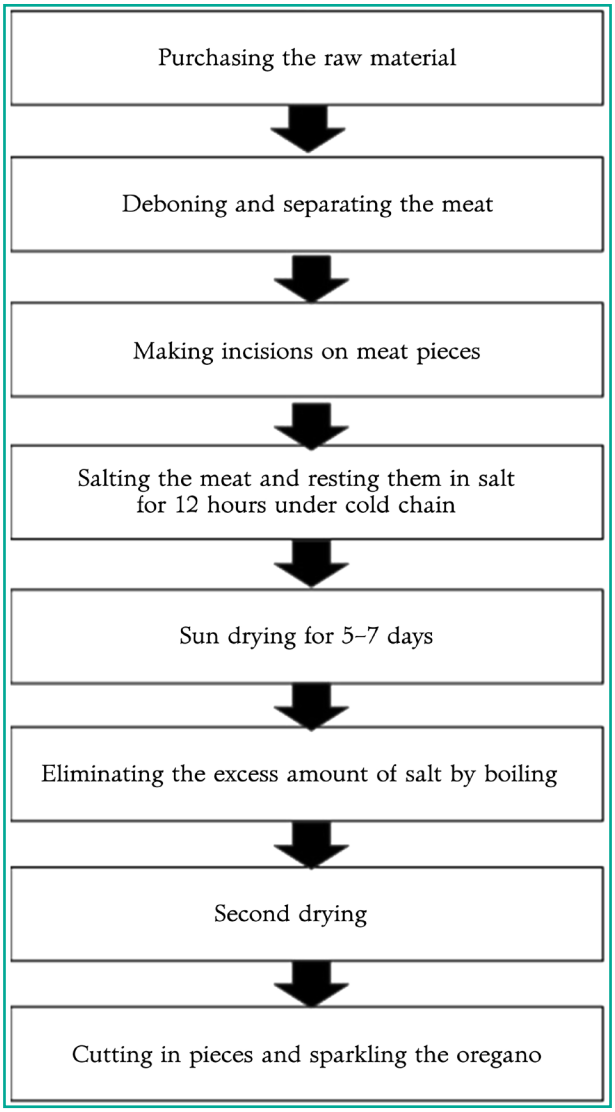

FIGURE 1: *Samarella production flow chart.*

pose a potential health hazard for consumers. Mycotoxins are secondary metabolites with a toxic effect produced by *A. flavus, A. parasiticus, P. commune* and *P. verrucosum* (Samson et al., 2004). Ochratoxin A, which has various carcinogenic effects on humans, has been detected in various dried meat products. (Monaci et al., 2005; Toscani et al., 2007). *P. commune* can grow well in food rich in carbohydrates and have been found to produce cyclopiazonic acid on meat substrates (Nunez et al., 1996). In some studies, it has been reported that *P. nalgiovense,* which can produce penicillin, has also been isolated (Papagianni et al., 2007; Andersan and Frisvad, 1994). In addition, thousands of spores can be disseminated into the air from moulds in production facilities, this can cause allergic disorders, chronic lung disease in employees of food processing plants. Most of these moulds are also known to cause deterioration in products and health problems in consumers (Dinçer and Erbaş, 2019).

Coagulase-negative cocci constitute the dominant bacteria in dried meats. These microorganisms provide the desired meat color in the product. Also, lactic acid bacteria (LAB) can be isolated commonly in dried meats that our produced in open air. The number of *Micrococcus, Staphylococcus* and *Pediococcus* species found in the final pre-packaged products has been reported to vary between 10^5–10^6 colony forming units (cfu)/g. In addition, it has been repor-

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ted that there can be food-borne pathogens e. g., *Listeria, Salmonell*a spp. Enterotoxigenic *Staphylococci* spp. and *E. coli* O157: H7, all of which can threaten the health of consumers (Naidoo and Lindsay, 2010).

Although literature is available on cured meat production, there is limited studies conducted on samarella. This study aims to determine the physicochemical and microbiological properties with bacteriological mycological profiles of samarella produced in Northern Cyprus.

Materials and methods

Sample collection design

Vacuum-packed products from various 32 markets in the North part of Cyprus were collected during sampling. The products, which were stored at +4 °C on market shelves, were delivered to the laboratory under cold chain. Samples were kept at +4 °C within their original packages until the analysis. Totally 100 samples were collected with their original packages. The criteria of selecting the samples was not to be expired shelf life.

Physicochemical analysis

Five grams of samarella samples were taken and analysed in a dry matter analyzer (Shimadzu Unibloc, Japan). For pH measurements, five grams of samples were homogenized with 45 mL distilled water in a blender for 1 min and measured with a pH meter (WTW InoLab pH 7110, Berlin, Germany). Mohr method was used to determine the salt content of samples described by Hecer and Ulusoy (2015).

Microbiological analysis

Under aseptic conditions, five grams of samarella samples were taken in sterile polyethylene bags and homogenized by adding 45 mL Maximum Recovery Diluent (Hecer and Ulusoy, 2015). Samples in Maximum Recovery Diluent up to 10^{-2} decimal dilutions were prepared after homogenization. Total aerobe mesophilic bacteria (TAMB), lactic acid bacteria (LAB), *Micrococcus/Staphylococcus,* Enterobacteriaceae, mold/yeast counts were plated onto selective media shown in Table 1. Plating was performed in duplicate for each dilution. The results were expressed as cfu per gram of dried meat and transferred to $\log_{10}$ value. The selective agars and incubation conditions are shown in Table 1.

Identification of moulds and yeasts

Moulds were identified based on macroscopic and microscopic evaluations. The macroscopic evaluations were based on the colony texture appearance, area of spread, and pigment (Samson et al., 2004; Frisvad and Samson, 2004). To identify yeast isolates, using the standard laboratory method were tested on the Vitek 2 (bioMérieux, USA) system according to the manufacturer's instructions. The Vitek® 2 YST cards were used for identification and susceptibility testing.

TABLE 1: *Selective agar and incubation conditions.*

Analysed microorganisms	Selective medium	Incubation parameters	References
Micrococcus/Staphylococcus	Baird Parker Agar (BPA) (LAB085)	37 °C / 48 h	Rahman et al. (2005)
Enterobacteriaceae	Violet Red Bile Glucose (VRBG) Agar (LAB031)	37 °C / 24 h	ISO 21528-2:2004
Mould/Yeast	Sabouraud Dextrose Agar (SDA) (LAB009)	25 °C / 72–96 h	Petit et al. (2014)
TAMB*	Standard Plate Count Agar (PCA) (LAB010)	37 °C / 48 h	Petit et al. (2014)
LAB**	De Man, Rogosa, Sharpe (MRS) Agar (LAB223)	30 °C / 48–72 h	ISO 15214:1998

*TAMB: total aerobe mesophilic bacteria; **LAB: lactic acid bacteria

TABLE 2: *Physicochemical analysis results of samarella samples.*

	Min	Max	Mean±Std
pH	5.97	7.86	6.36±0.30
Salt (%)	7.21	24.02	12.75±0.29
Dry-Matter (%)	27.06	65.05	41.40±1.03

Statistical analysis

Results were calculated by using SPSS (Demo Version 22.0, IBM, Armonk, NY, USA) program as minimum-maximum and mean values. The data are shown as the mean of three replicates for each analysis.

Results

Physicochemical results

Dry matter, pH and salt results of samarella samples are given in Table 2. According to the analysis results, the amount of dry matter was in the range of 27.06–65.05%. In our study, pH mean values of samarella samples were found to be 6.36 ± 0.30 and in the range of 5.97–7.86. In the study, salt amount of 100 samarella samples were in the range of 7.21–24.02% and with mean result of 12.75 ± 0.29%.

Microbiological results

The minimum-maximum and mean results of TAMB, *Staphylococcus/Micrococcus,* LAB, coliform and mold/yeast numbers of samarella samples are given in Table 3. In this study, the number of TAMB for 100 samarella samples was found in the range of 2.30–4.13 $\log_{10}$ cfu/g and with the mean of 3.88 ± 0.28 $\log_{10}$ cfu/g. The LAB numbers of the samarella samples were found in the range of 2.00–3.92 $\log_{10}$ cfu/g and with the mean of 3.18 ± 0.41 $\log_{10}$ cfu/g. *Staphylococcus/Micrococcus* numbers were found in the range of 3.32–4.40 $\log_{10}$ cfu/g and with the mean of 3.45 ± 0.41 $\log_{10}$ cfu/g. Yeast and mold numbers were found in the range of 1.47–2.60 $\log_{10}$ cfu/g and with the mean of 2.15 ± 0.20. All the microbiological analysis results as cfu/g log10 are given in Table 3.

TABLE 3: *Microbiological analysis results ($\log_{10}$ cfu/g).*

	Min	Max	Mean±Std
TAMB	2.30	4.13	3.88±0.28
LAB	2.00	3.92	3.18±0.41
Mould/Yeast	1.47	2.60	2.15±0.20
Micrococcus/Staphylococcus	3.32	4.40	3.45±0.41
Enterobacteriaceae	0.00	1.11	0.18±0.46

Mycological results

A total of 157 moulds and 128 yeast were isolated. The isolates belonged to 15 species of four mould genera. These generas were *Penicillium, Cladosporium, Eurotium* and *Aspergillus.* It is shown in Table 4. The generas Penicillium generally dominated the microbiota of sama-

rella, by covering 65.57% of the total isolates. *Cladosporium* generas contributed 7.64% to total insolates. Other isolates belonged to *Eurotium* and *Aspergillus* species with 5.09% and 14.63% ratios respectively. In Samarella's mould microflora, 30.57% with *P. nalgiovense* has been seen to dominate.

A total of 128 yeast isolates were identified belonging to three generas: *Candida* (67 isolates), *Yarrowia* (10 isolates) and *Debaryomyces* (51 isolates). During samarella processing, the predominate yeast generas was *D. hansenii* which represented 39.84% of the generas. It is shown in Table 5. Other predominant generas isolated during samarella processing were *Candida zeylanoides* (30.46%), *Candida deformans* (8,59%) and *Yarrowia lipolytica* (7.81%).

Discussion

Factors such as nutrients in the food matrix, temperature, humidity and pH are effective for microorganisms to thrive in food. With the drying process, most of the humidity in food is removed and microbial growth is reduced. Dry matter ratios of samarella samples in our study are shown in Table 2. Ulusoy et al. (2018) reported the dry matter ratios as 65.20–65.50% in samarella samples and these values were higher than our study. Those lower ratios may be due to the characteristics of the experimental study. In the current study, the samples were collected from markets and due to the storage time at market shelfs the dry matter ratio may increase. On the other hand, the reported values for dry matter in other meat products prepared by drying in the sun were close to the results that we obtained. For instance; Pettit et al. (2014) obtained the dry matter at ratio of 35–41% in biltong samples and Ratsimba et al. (2019) reported that they found the dry matter at ratio of 32.8–50.3% in kitoza samples. In order to obtain a more homogeneous result in the collection of samples, products from different manufacturers were collected. Unfortunately, there is no standardization for production process and manufacturers may use different traditional production processes. This causes some of the products to be drier or more humid. Especially small businesses do not apply too much drying process to put the product on sale in a shorter time. It is thought that the difference stems from this. On the other hand, dry matter ratio may be higher in the product which are close to expire date.

TABLE 4: *Moulds isolated from samarella samples.*

	Number of strain	Prevalence (%)
Aspergillus fumigatus	7	4.45
A. vesicular	6	3.82
A. niger	4	2.54
A. terreus	3	1.91
A. penicilloides	3	1.91
Cladosporium cladosporiodes	12	7.64
Eurotium amstelodami	11	7
E. herbariorum	8	5.09
Penicillium atramentosum	16	10.19
P. brevicompactum	10	6.36
P. chrysogenum	5	3.18
P. commune	7	4.45
P. crustosum	6	3.82
P. nalgiovense	48	30.57
P. solitum	11	7
Total	157	

TABLE 5: *Yeasts isolated from samarella samples.*

	Number of strain	Prevalence (%)
C. zeylanoides	39	30.46
C. deformans	11	8.59
C. galli	2	1.56
C. alimentaria	9	7.03
Y. lipolytica	10	7.81
D. hansenii	51	39.84
C. famata	2	1.56
C. sake	4	3.12
Total	128	

Ulusoy et al. (2018) reported pH values in samarella samples in the range of 5,90–6,10. Vilar et al. (2000) (2000) reported 5.95–6.26 in lacon samples, Rahman et al. (2005) reported for dried meat as 5.97 and it was observed that the results in our study were close to these values. To obtain proper, good quality dried meat this average of pH is needed.

Salt amounts of samarella samples were found in a wide range of 7.21–24.02% as shown in Table 2. Ulusoy et al. (2018) reported that they found the amount of salt to be 17.50–17.70% in samarella samples. In the studies on Biltong, Burfoot et al. (2010) obtained 3–13%, Petit et al. (2014) obtained in the range of 5.5–7.9%, Engez et al. (2012) reported in the range of 2.68–3.30%. This is because limits are not specified by any legal regulations in the production of samarella. This varies depending on the use of different salt proportions by producers. It is thought that the amount of salt reported in the studies is due to the difference in the amount of salt used in the production processes of the products. Samarella production is usually carried out in line with customer demands. In Cyprus, consumers want salty products. Manufacturers, keep the amount of salt excessive in their production processes depending on these demands. Samarella is often used as an appetizer with drinks. But in ancient times, as the tradition of the product, it is produced using more salt in order to preserve the meat for a longer time. On the other hand, salt ratio may be higher in the product which are close to expire date.

The number of TAMB is a parameter used to assess the level of contamination and ultimately determine whether food is suitable for human consumption (Matsheka et al., 2014). TAMB value is important since samarella is a ready-to-eat food. There is no legal limit for TAMB in samarella. For this reason, the limit (6–7 $\log_{10}$ cfu/g) that set up in previous research studies for similar dried meat products was defined as the limit for this study (Burfoot et al., 2010). The TAMB values in our study were found to be below this limit. The first experimental study on samarella was conducted by Ulusoy et al. (2018) and according to the reported results of this study, the number of TAMB was at the level of 3.84–3.86 $\log_{10}$ cfu/g. The number of TAMB in other products prepared by salting and drying in the sun were; 4 $\log_{10}$ cfu/g in biltong samples (Matsheka et al., 2014), 3.30 $\log_{10}$ cfu/g in dendeng stalk samples consumed in Indonesia. These results are close to those found in our study. Naidoo and Lindsay (2010), Shale and Malebo (2011) reported that they found TAMB values in the range of 4–6 $\log_{10}$ cfu/g,

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6.20–7.59 $\log_{10}$ cfu/g, respectively. Çakıcı et al. (2015) reported TAMB 7.10 $\log_{10}$ cfu/g in pastrami which is a cured and dried meat product. This value was found to be higher than the results we found in our study. This is because the implementation of different production processes is due to the changes in hygiene conditions in production and sales locations.

The presence of LAB, *Staphylococcoccus/Micrococcus* and mold/yeast in dried meat products is due to the fact that these microorganisms can tolerate low pH, salt and low water activity. In addition, the production process of dried meat products (salting, drying) allows the development of these microorganisms (Purrinos et al. 2013; Öz et al. 2017). For this reason, LAB analyses are performed in dried meats, although they are not included in the standards. Ulusoy et al. (2018) found the number of LAB in samarella samples in the range of 2.69–2.70 $\log_{10}$ cfu/g, Vilar et al. (2000) reported 3.39 $\log_{10}$ cfu/g in biltong samples. These results are close to the ones that we obtained. Similar salt ratios may cause similar number of LAB. Öz et al. (2017) obtained 3.30–7.90 $\log_{10}$ cfu/g in pastirma samples, Jones et al. (2017) reported 8 $\log_{10}$ cfu/g in biltong samples. As presented in Table 3, the values were found to be above than our study.

Ulusoy et al. (2018) reported the number of *Staphylococcoccus/Micrococcus* as 2.47 $\log_{10}$ cfu/g in their study for samarella samples produced by experimental methods and it was found to be lower than the results in our study. This may be due to the difference in experimental design. Bennani et al. (2000) reported that dried meats produced by traditional methods have a higher number of Staphylococcus than those produced by experimental methods. Bennani et al. (2000) reported that the number of Staphylococcoccus/Micrococcus was 5.87 $\log_{10}$ cfu/g in the samples of kaddid sold in the markets. In research studies for pastirma samples, Aksu and Kaya (2001) obtained 4,00–7,45 $\log_{10}$ cfu/g, Ozdemir et al. (1999) obtained 4–7 $\log_{10}$ cfu/g, Doğruer et al. (1995) reported that they found 5.89 $\log_{10}$ cfu/g regarding *Staphylococcoccus/Micrococcus* counts in a different type of dried meat products and those results are higher than the results that we obtain in our study.

These differences in LAB number, mold/yeast number and *Staphylococcoccus/Micrococcus* number of products are caused by the production of products using traditional methods, depending on the hygiene conditions in the environment and sales places.

It has been reported that the maximum number of *Enterobacteriaceae* in dried meat products should be 2 $\log_{10}$ cfu/g. Studies have reported that *Enterobacteriaceae* cannot develop in the production processes of dried meats by salting and drying and since the water activity is below 0.9. In our study, no samples were found to carry above 2 $\log_{10}$ cfu/g was *Enterobacteriaceae* (Vilar et al., 2000; Öz et al., 2017; Bennani et al., 2000; Kaban, 2009).

According to the previous research studies, yeast characterization in dried meat products is similar to yeasts isolated from raw red meats (Asefa et al., 2009). Studies show that *D. hansenii* and *C. zeylanoides* are often isolated yeast in dried meat products. *D. hansenii,* which has the ability to grow even at high salt concentrations and at low aw values, was also seen to be the dominant species in this study.

Yeasts can contaminate foods from different soures such as air, equipment and food handlers during the preparation of food. Due to the fact that yeasts are resilient to high osmotic and low pH conditions and low temperatures, they constitute undesirable effects on the physical, chemical and organoleptic properties for the products. The deterioration of food by yeasts is known to cause significant losses during processing and conservation.

Sonjak et al. (2011) reported that mold-yeast development is frequently observed in dried meats due to environmental conditions, and *Aspergillus, Eurotium* and *Penicillium* moulds were isolated in studies. Ulusoy et al. (2018) obtained yeast/mold in the range of 3.69–3.70 $\log_{10}$ cfu/g in samarella samples and Burfoot et al. (2010) reported 2–5 $\log_{10}$ cfu/g in biltong samples. These results were found to be higher than the mold/yeast results found in our study. *Penicillium* generas has dominated the mould mycobiota of Samarella. In particular, *P. nalgiovense* was the dominant mould generas, forming 30.57% of the isolated mould generas. Other than *Penicillium atramentosum* and *P. solitum,* the other most frequently isolated generas are *P. nalgiovense,* which are associated with dry-cured meat products (Papagianni et al., 2007; Sorensen et al., 2008). *P. nalgiovense, P. solitum* and *P. commune* which are tolerant to high level salt concentration. The presence of *P. nalgiovense* in products may cause health problems in consumers due to the fact that some strains produce penicillin. Since some people are allergic to antibiotics such as penicillin, the presence of such allergic compounds in dried meat products can be dangerous for consumers. On the other hand, it has been reported that *P. nalgiovense* is used as a starter culture in some dried meat products (Papagianni et al., 2007; Andersen and Frsivad, 1994). With the except *P. solitum,* all dominant isolated generas of *Penicillium* are known to be able to produce toxic secondary metabolites such as mycotoxins.

The frequencies of isolation of *Cladosporium* and *Eurotium* generas are relatively high. *Eurotium* spp. has been reported in previous studies to be among the dominant types of microbiota of dry-cured meat products (Comi et al., 2004). Nunez et al. (1996) has reported that during their long ripening duration in the preparation of products, *Penicillium* was fractionally replaced with *Aspergillus* and *Eurotium.* The majority of *Eurotium* spp. were isolated from relatively longer dried samarella samples in this study. The presence of *Cladosporium* generas isolated in samarella products has been seen to be compatible with studies carried out in Greece and Slovakia.

Although the development of bacteria is inhibited due to the low water activity (0.9–0.6) of dried meats, xerophilic yeasts may develop. The frequently isolated yeasts from meats are *Candida, Debaryomyces* and *Torulopsis.* depending on the examination of samarella samples, it was seen that the dominant yeast species was *D. hansenii* with 39.84%. Other dominant generas isolated in samarella samples were *Candida zeylanoides* (30.46%), *Candida deformans* (8.59%) and *Candida alimentaria* (7.03%). However, this study is the first to characterize the yeast dynamics of samarella, *D. hansenii* and *C. zeylanoides* have been shown to be yeast generas that are frequently isolated in other similar dried meat products. The reason why *D. hansenii* was found to be high in this study is thought to be resistant to high salt concentrations and low aw values (Breuer and Harms, 2006). Furthermore, studies have reported that *D. hansenii* actively reproduces at temperatures above 4 °C. In our study, the other yeast species that was isolated was *C. zeylanoides,* and other studies have reported that it was the dominant generas (Asefa et al., 2009; Purriños et al., 2013). Asefa et al. (2009) *D. hansenii* and *C. zeylanoides* reported dominant yeasts in dried meats produced in Norway. In their study, Purrinos García Fontan et al. (2013) no-

tified that *D. hansenii* formed the dominant flora inside and outside of the samples. It was reported that *C. zeylanoides* are also found in fresh and frozen meats. The microflora of dried meats has often been shown to be compatible with the microbiota of fresh meats. Studies have notified that *C. zeylanoides* have no pathogenic effect (Purrinos et al., 2013).

Y. lipolytica, C. deformans, C. galli and *C. alimentaria* were reported to be the yeasts that were frequently isolated from meat and meat products. *Y. lipolytica* is the unique generas in the sexual (teleomorph) genus *Yarrowia* and has its asexual state (anamorph) classified in the genus *Candida berkhout* as *C. lipolytica* (Knutsen et al., 2007). *C. deformance* belongs to the genus *C. galli* and *C. alimentaria.* Therefore, they are genotypically closely related to *Y. lipolytica.* The results of our study don't show one-to-one compatibility with yeasts isolated in other dried meat products. This is thought to be due to different conditions of drying and raw material used in production.

This study is the first to identify moulds and yeasts associated with the samarella dry-cured meat production processes specific to Cyprus. A total of 157 moulds belonged to 15 species of four mould generas were isolated. These generas were Penicillium, Cladosporium, Eurotium and Aspergillus. The generas Penicillium generally dominated the microbiota of samarella, by covering 65.57% of the total isolates. 8 species of yeast *(C. zeylanoides C. deformans, C. galli, C. alimentaria, Y. lipolytica, D. hansenii, C. famata, C. sakewere)* were isolated in samples. This study can be useful to indicate the types of possible toxic metabolites that may be present on samarella samples and their importance for public health. The study could strengthen the manufacturer's risk management program for microbiological hazards and is thought to be a starting point for further characterization of isolates. Results of in our survey showed us the necessity of establishing a standard for the product. It is necessary to prevent quality differences and produce more more microbially reliable products. Quality and microbially safe products are also important for public health. Our study will serve as a reference for future studies.

Conflict of interest

The authors declare that they have no conflict of interest.

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