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Research Article

The Effect of Beet (*Beta vulgaris*) Juice Solutions on Secret Icing

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Abstract

In our country, salt is poured to prevent hidden icing. However, the excess of salt used causes the onset of global warming, the increase of fresh water insufficiency, and improper irrigation and fertilization. Living things are directly or indirectly damaged by these negative effects. With this research, it is to obtain an environmentally friendly, economical and recycling-based solution that tries to prevent accidents caused by hidden icing. Solutions were obtained with the help of substances (NaCl and Aloe vera) mixed with waste beet juice. The prepared solutions were kept at -18 and -22 °C. When the solutions prepared at the end of the 1st, 3rd, 5th and 7th days were examined, it was determined that there was no icing. In order to reduce the freezing temperature of the water to -9 °C, 29 g of NaCl is dissolved in 100 ml of water. Considering the damage of excess salt to the environment, 3 different applications were made to 8 different solutions in -18 and -22 °C environments. Common results were obtained at both temperatures. While an increase in density is observed in the solutions, icing is not observed at all. This solution can be developed by choosing different salt concentrations and cold resistant plants that are easier to grow and less costly.

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Hidden icing
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Pancar (*Beta vulgaris*) Suyu Solüsyonlarının Gizli Buzlanmaya Etkisi

Özet

Ülkemizde gizli buzlanmayı önlemek için tuz dökülmektedir. Ancak kullanılan tuzun fazlası küresel ısınmanın başlamasına, tatlı su yetersizliğinin artmasına, yanlış sulama ve gübrelemeye neden olmaktadır. Bu olumsuz etkilerden canlılar dolaylı ya da doğrudan zarar görmektedir. Bu araştırma ile gizli buzlanmanın neden olduğu kazaları önlemeye çalışan, çevre dostu, ekonomik ve geri dönüşümü esas alan solüsyon elde etmektir. Atık pancar suyu ile karıştırılan maddeler (NaCl ve Aleo vera) yardımıyla solüsyonlar elde edilmiştir. Hazırlanan solüsyonlar -18 ve -22 0C'lik ortamda bekletildi. 1., 3., 5., ve 7. gün sonlarında hazırlanan solüsyonlara bakıldığında buzlanma olmadığı tespit edildi. Suyun donma sıcaklığını -9 ^{0}C düşürebilmek için 100 ml su içerisine 29g NaCl çözdürülmektedir. Fazla tuzun çevreye olan zararı göz önünde tutularak -18 ve -22 ^{0}C'lik ortamlarda 8 farklı solüsyona 3 farklı uygulama yapılmıştır. Her iki sıcaklıkta ortak sonuçlar elde edilmiştir. Solüsyonlarda yoğunluk artışı gözlemlenirken, buzlanma ise hiç görülmemektedir. Bu solüsyon, farklı tuz konsantrasyonları ve maliyeti daha düşük, yetiştirilmesi kolay olan soğuğa karşı dirençli bitkiler tercih edilerek geliştirilebilir.

Anahtar Kelimeler
Gizli buzlanma
Pancar suyu
NaCl
Aleo vera
Geri dönüşüm

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INTRODUCTION

In winter, snowfalls combine with the wind and cause hidden icing on highways. Icing on the roads causes material and moral damage. As a result of snowfall, snow accumulation or icing appears on the roads. Different methods are used to get rid of both negative situations. The application made before the formation of icing is called anti-icing, the method applied after the formation of ice is called de-icer or de-icer. The purpose of these procedures is to reduce accident and death rates. Basically, solid and liquid chemical applications are made. This method has been used since the 1930s. This method has advantages and disadvantages. In this method, sodium chloride (NaCl), calcium chloride (CaCl2), magnesium chloride (MgCl2), potassium chloride (KCl), urea (NH2), calcium magnesium acetate (CMA), potassium acetate (KCO2H), alcohol, glycol, antifreeze etc. substances are used. In our country, NaCl, CaCl2 and MgCl2 are mostly used to prevent icing [1]. These cheapest and easiest to find substances destroy the environment. The excess of chemicals used harms the road, metal parts and the environment. The ability of these chemicals to dissolve ice is reduced below -10 degrees Celsius. It is not as successful as expected, and it is not environmentally friendly either. Liquid solutions are the application method of solutions obtained as a result of the liquefaction of solid chemicals. Its advantages over solid chemicals are that it reacts faster, labor is saved as it is applied as a liquid, and the damage of salt to asphalt and the environment can be reduced by mixing different substances. Its disadvantages are that its chemical properties will decrease depending on the solution to be prepared, so its effect may decrease.

In our country, 5 g of salt is poured per m2 to prevent hidden icing [2]. The salt used lowers the freezing temperature of the water. However, the excess of salt used causes the onset of global warming, the increase of fresh water deficiency, and various problems such as improper irrigation and fertilization [3]. The excess of salt coming into the soil can spread over a wide area with precipitation. Living things are directly or indirectly harmed by this event. Plants try to resist biotic (pathogens, insects and herbivores including viruses, bacteria and fungi) and abiotic (cold, heat, drought, salinity, oxidative stress) stresses in nature [4]. They disrupt the balance between the production and scavenging of reactive oxygen species (ROS) in plants and also cause structural and metabolic damage [5,6]. If the plants that encounter salt stress cannot respond with antioxidant defense enzymes, they cannot show their vital activities. These losses can cause damage to vegetation and limit the growth of various plants. While the salt used is trying to help in the hidden icing, the excess causes environmental pollution. Global warming occurs when greenhouse gases (CO2, CH4, N2O, H2O, O3, etc.) formed as a result of nature and human influence, keep the heat in the lower layers of the atmosphere. Some greenhouse gases formed as a result of natural processes can be directly or indirectly affected by human activities. The remaining greenhouse gases are produced directly by human activities. The fossil fuels used trigger global warming [7]. The increase in global warming causes the soil to become dry and the soil salt ratio to increase. The salting method applied in the winter months and the increase in the salt content of the water resources and the soil adversely affect the living things living in the environment. Although such applications are used to combat icing, they secretly disturb the balance of the environment. The dangerous consequences of such practices are likely to emerge in the coming years.

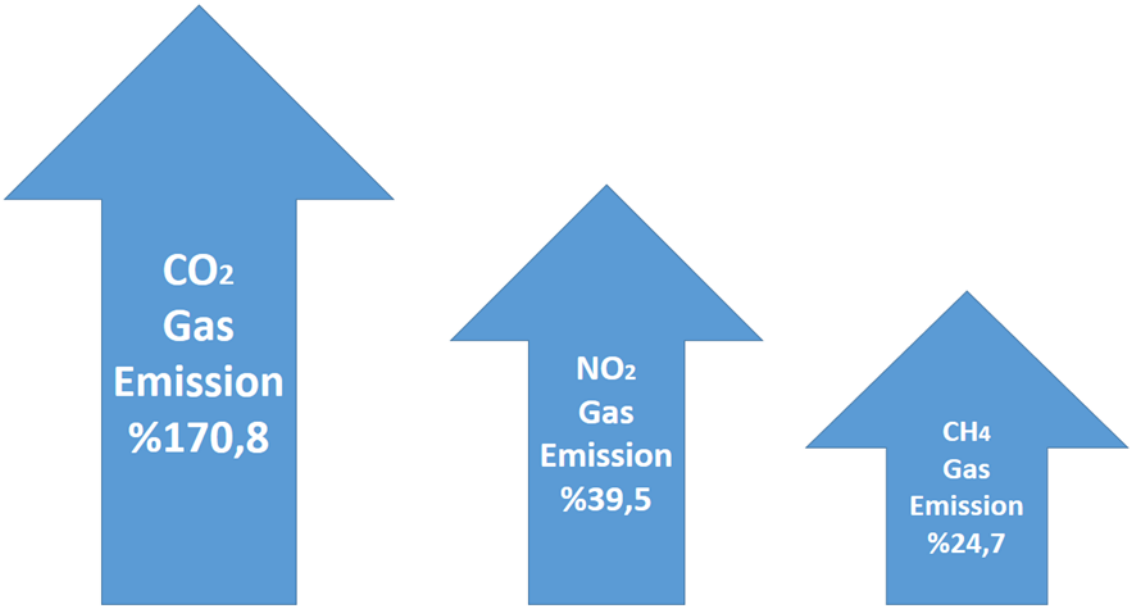


Figure 1: According to the National Greenhouse Gas Inventory report, the amount of increase in gases between 1990 and 2015 (TUIK, 2017) is shown.

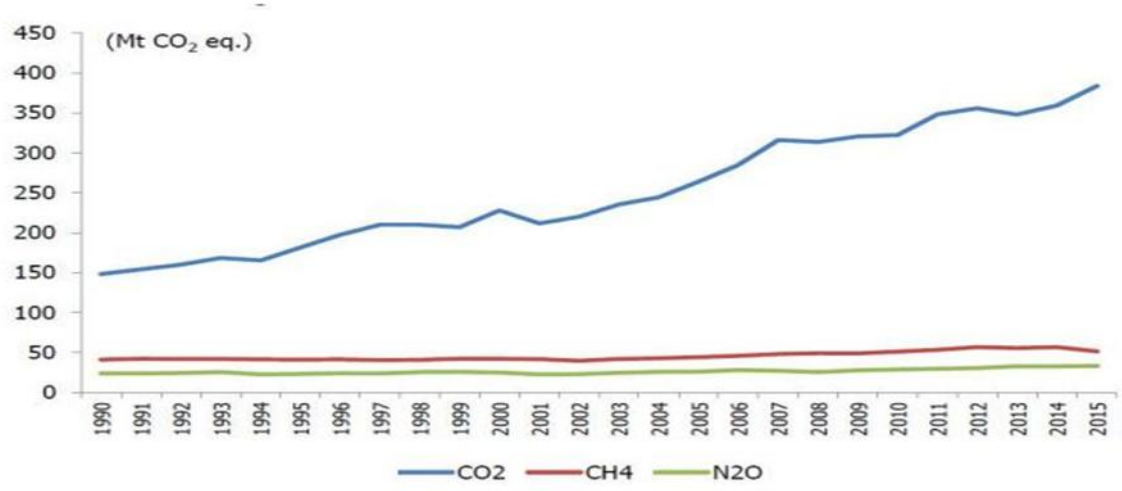


Figure 2: The graph of the increase in greenhouse gases between 1990 and 2015 (TUIK 2017) is shown.

Substances that must be removed from the environment we live in, that have expired and are harmful to human health are called waste materials. These substances, which cannot be removed, cause environmental pollution. Living and non-living things can be damaged due to environmental pollution. The process of regaining the material components of the products that have been used or lost their function is called recycling [8]. As a result of recycling these products by applying various chemical or physical methods, the environment, natural resources and economy are protected. From past to present, natural resources have been used continuously, and they have started to run out as time goes on. For this reason, people have started to turn to new searches and reprocess waste materials. Reusing waste materials saves more energy, more work and more time than re-manufacturing.

Beetroot is a herbaceous plant from the spinach family (*Chenopodiaceae*). It is a biennial plant and its height can vary between 20-50 cm. In the chemical composition of sugar beet; water (76.5%), dry matter content (23.5%), sucrose (16.5%), pectin (2.5%), cellulose (1.2%), nitrogenous substances (1.1%), mineral substances (1.7%), lipids (0.1%) and other components (0.4%). Sugar beet (23%), which ranks second after sugar cane (77%) in world sugar production, can be produced in cool and temperate places, unlike sugar cane [9,10]. The provinces that produce the most sugar beet in Turkey are Konya, Eskişehir, Tokat, Afyonkarahisar, Amasya, Ankara, Sakarya and Bursa. The cultivation area devoted to sugar beet in our country has decreased since 1999 [11]. While the leaves of the processed beet are used as animal feed, the juice (sorbet) formed as a result of pressing is used as a waste material or as a rooting agent in the banana plant. In addition, molasses, spirit, ethanol and chocolate foods are produced in sugar beet [1,12]. World sugar beet production has averaged 261 million tons in recent years. In the 2016-2017 production season, it increased by 13% compared to the previous season. In other words, production increased from 261 million tons to 277 million tons. This increase is due to the increase in the production of countries such as Russia, Turkey and Poland [13]. Turkey ranks 3rd among EU countries in sugar beet production [13].

Aloe vera plant, which is from the Aloaceae family, has begun to spread in areas such as North Africa, the Arabian Peninsula, China and the Mediterranean Region, although its homeland is not the rain-free regions of South Africa, Arabian Countries and Madagascar [14]. The Turkish name of the plant is "yellow sword" [15], in the Arab world it is called "shining and bitter" because its taste is bitter [16]. Succulent (Succulent means a plant capable of holding and accumulating water in the special fleshy tissues of the stem or leaves.) The plant has 99% water in its structure. In addition, the plant pH 4.5 shows slightly acidic properties. *Aloe vera* leaves have two different parts, latex and gel [17]. A.vera gel contains amino acids, minerals, enzymes, vitamins and organic compounds with biological and healing properties [18]. In the shell part, there are different minerals, amino acids, vitamins, sugar, enzymes and fatty acids [19]. The growth and development temperature conditions of each plant differ. The optimum temperature for one plant can cause stress for another plant. This plant, which has a succulent body, is resistant to -7 degrees.

Plants exposed to cold stress can cause decreased leaf expansion, wilting, yellowing of leaves and tissue death (necrosis) [20]. Some plants are gaining tolerance to cold stress. Plants perform cold acclimation to reduce the damage caused by cold [21]. As a result of freezing of water in plants under cold stress, tissue dehydration and consequent plasma membrane damage are observed [22]. This damage is more common in plants with succulent stems. ROS (reactive oxygen species) production increases in the cells of plants exposed to oxidative stress. The produced ROS are removed by the antioxidant defense enzymes of the plants. When the ROT level is higher than the plant's removal level, the plant cannot defend itself. In this case, there is an increase in lipid peroxidation in biological membranes and cell death begins [23]. Successful plants are resistant to stress, and plants that cannot defend themselves are called susceptible plants [24]. Although the aloe vera plant showed succulent stem characteristics, it provided tolerance to cold stress. The plant is able to survive by preventing the freezing of its water content while protecting itself against cold stress.

MATERIAL AND METHOD

Sugar is extracted by pressing sugar beet in the sugar factory. The juice of the beet, which passes through various processing steps, is extracted as waste material. As seen in Figure 1, the process steps were applied to the beet juice, which was supplied as waste material, in order. Solution preparation: In Figure 3, 8 different solutions were prepared in

different beakers. After adding the necessary materials into the solution, it was homogenized with the help of a magnetic stirrer.

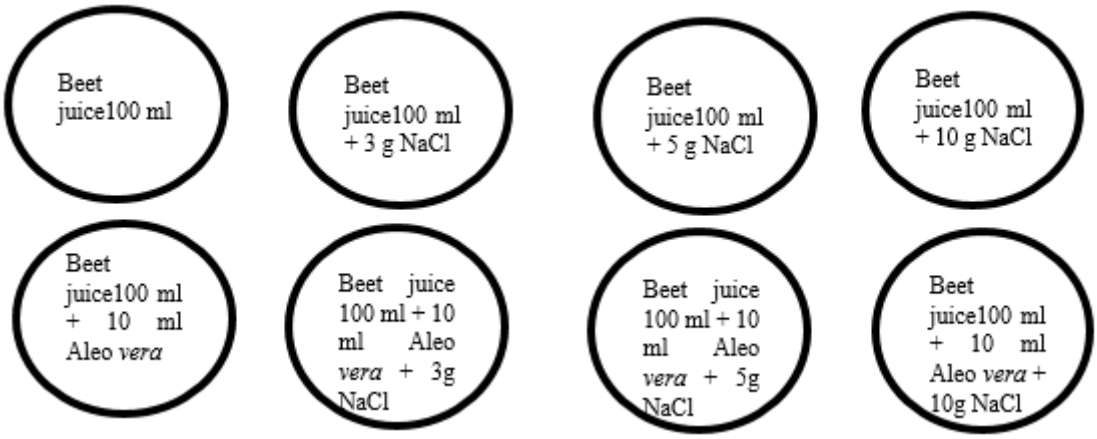


Figure 3: Shows the preparation scheme of herbal solution varieties.

The created solutions were transferred to separate petri dishes with 10 ml. Three of each group were prepared. These solutions were kept at -18 and -22 0C for 7 days. In addition, the same solutions were applied separately to an icy environment at -18 0C. As a result of this process, the reactions of the frosted environment in 7 days were examined.

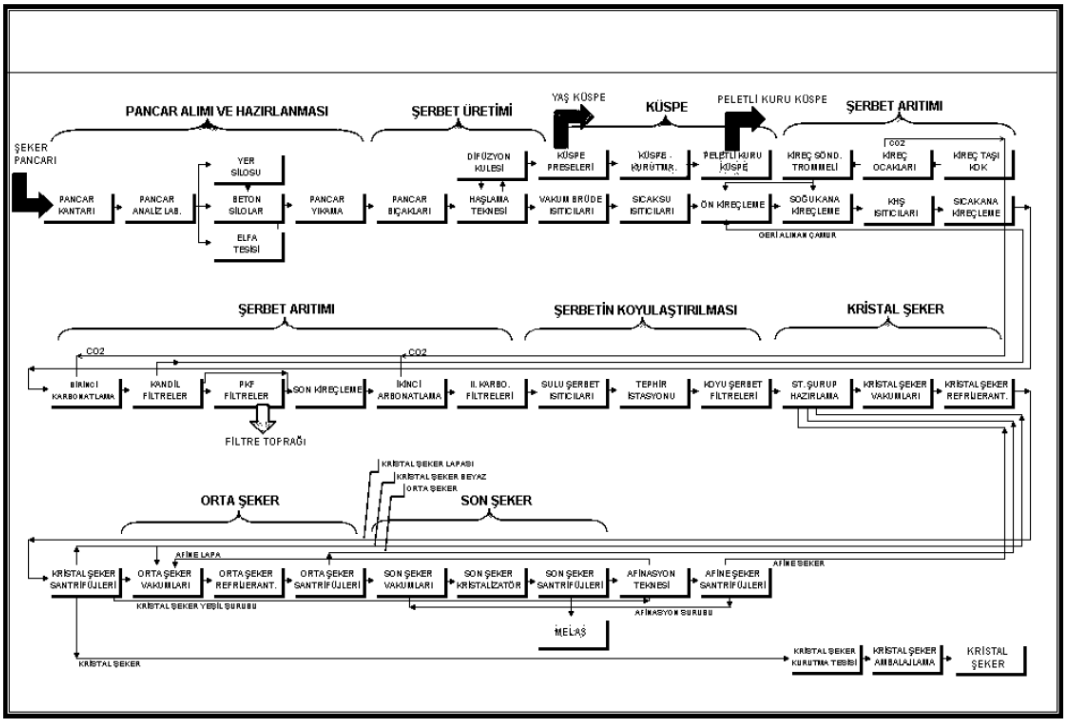


Figure 4: Shows the sugar production flow chart. [25].

2.1. Sugar beet juice (molasses)

The sugar production scheme is shown in Figure 4. Molasses extracted in the last stage was supplied from Torku factory. The supplied molasses was used in the solution preparation steps. The substances found in this molasses are shown in Table 1. These data are the results of analysis obtained in a private laboratory.

Solution Content (%)	
pH	5,6
Intensity	1,21
Organic Matter	45,5
Organic Carbon	13,1
Organic Nitrogen	1,83
Total Nitrogen	2,02
Total Magnesium Oxide	5,3
Total Potassium Oxide	5,1
Total Calcium Oxide	1,2
Total Sodium	1,4

Table 1: shows the solution content of beet molasses.

2.2 Calculation of icing states of solutions

The solutions obtained as a result of the research were poured into different petri dishes at the same rate. The icing conditions of the solutions at -18 and -22 ^{0}C were investigated. Percentages were determined according to the solid state of the solutions before and after the application. The low-grade responses of the solutions were examined within the specified days.

2.3 Calculation of the concentration percentage of solutions

The fluidity conditions of the solutions obtained as a result of the research were examined. The fluidity rates of the liquids were investigated before and after the application. Concentration percentages were calculated according to the obtained data.

2.4 Calculation of thawing percentages of solutions

The solutions were applied to the iced water in petri dishes. The initial thickness and weight of the ice were measured. As a result of the solution application, the thickness of the ice was calculated on the 0th, 3rd, 5th and 7th days. According to the application days, the thickness of the ice was examined. Obtained results were graphed.

2.5 Preparation of *Aloe vera* plant extract

Leaves taken from *Aloe vera* plants are separated from the stem. The gels in the separated leaves are removed. The gels obtained are crushed and added to the solution. The mixture is homogenized with a magnetic stirrer. Since the *aloe vera* plant is easy to grow, it can be grown easily if needed. The cost of growing these plants, which have rapid reproduction, is very low.

2.6 Preparation of salt concentration

The NaCl used for the solutions was obtained from the Merck company (ma:58,44). The salt concentration was calculated at different rates. Appropriate concentrations were added to the solution and homogenized with the help of a magnetic stirrer.

2.7 Statistical Analysis

The averaged data were calculated by statistical analysis of variance method (SPSS, ANOVA) by performing 3 replications for each group.

3. Findings and Discussion

The results of the 1st, 3rd, 5th and 7th days of the prepared solutions are shown in the charts below. Solution groups are denoted by the letters A, B, C, D, E, F, G, and H in the chart. (A: Beet juice, B: Beet juice + 3 g NaCl, C: Beet juice + 5 g NaCl, D: Beet juice + 10 g NaCl, E: Beet juice + Aloe vera, F: Beet juice + Aloe vera + 3 g NaCl, G: Beet juice + Aloe vera + 5 g NaCl, H: Beet juice + Aloe vera + 10 g NaCl)

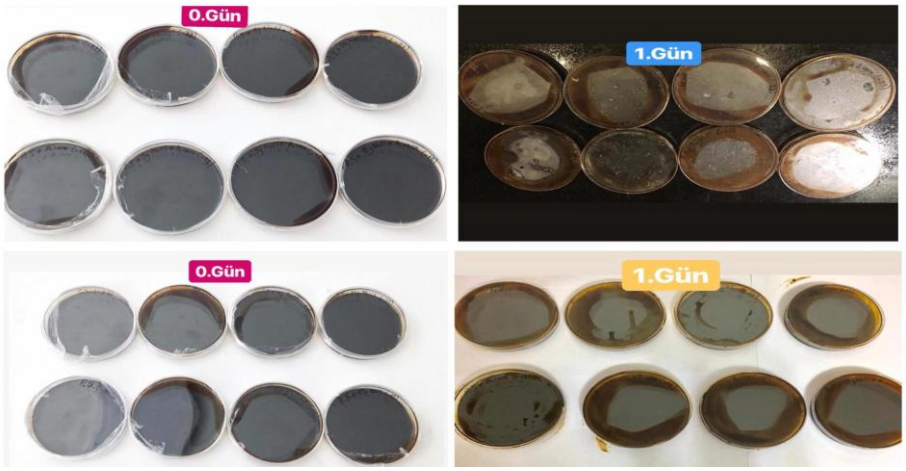


Figure 5: Shows the 0 and 1 day icing rates of the solutions.

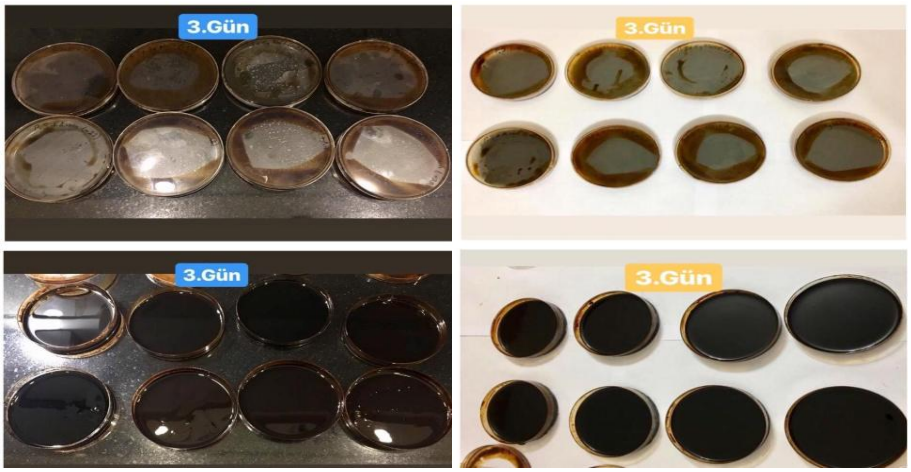


Figure 6: Shows the 3rd day icing rates of the solutions.

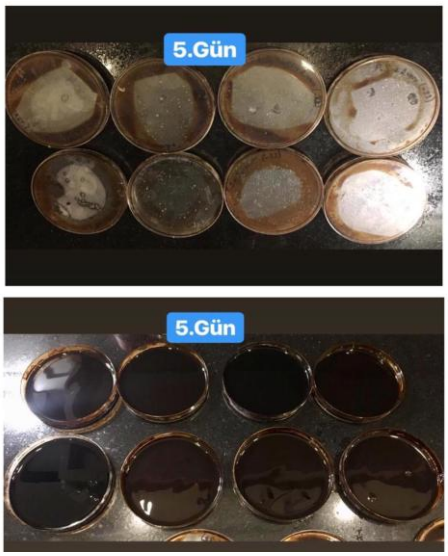


Figure 7: Shows the 5th day icing rates of the solutions.

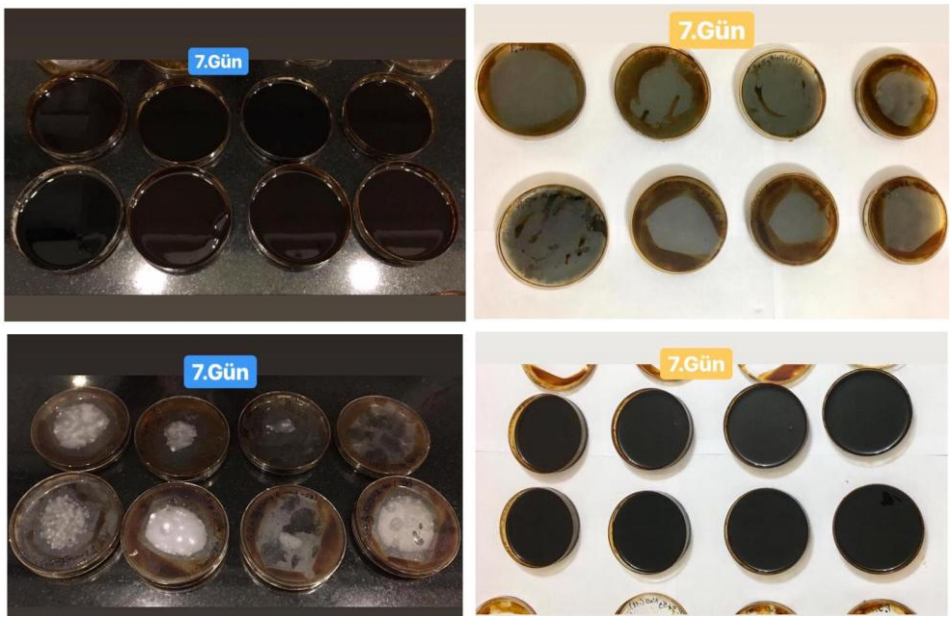


Figure 8: Shows the 7th day icing rates of the solutions.

The 1st, 3rd, 5th and 7th days of application pictures of the solutions at -22 0C and -18 0C (blue -22 0C and yellow --18 0C) are shown above.

No icing: - There is icing: +
Table 2: The effect of 1st day solution application on icing
1. DAY

		A	B	C	D	E	F	G	H
Icing conditions	**-18**	-	-	-	-	-	-	-	-
	-22	-	-	-	-	-	-	-	-

As seen in Table 2, no icing was observed at -18 and -22 degrees.
Table 3: The effect of solution application on icing on the 3rd day
3. DAY

		A	B	C	D	E	F	G	H
Icing conditions	**-18**	-	-	-	-	-	-	-	-
	-22	-	-	-	-	-	-	-	-

As seen in Table 3, no icing was observed at -18 and -22 degrees.

Table 4: The effect of solution application on icing on the 5th day
5. DAY

		A	B	C	D	E	F	G	H
Icing conditions	**-18**	-	-	-	-	-	-	-	-
	-22	-	-	-	-	-	-	-	-

As seen in Table 4, no icing was observed at -18 and -22 degrees.

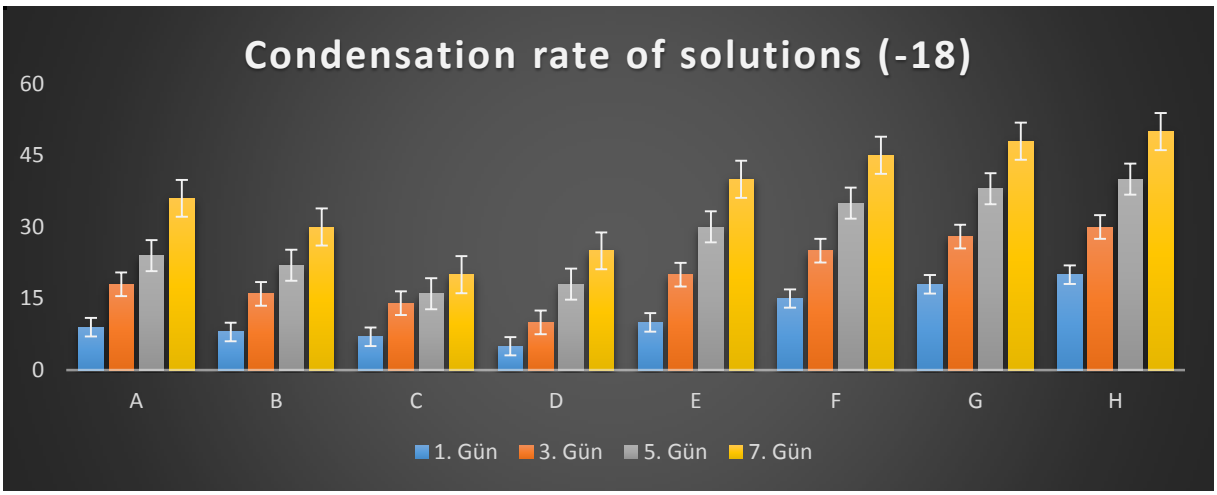
Table 5: The effect of solution application on icing on the 7th day
7. DAY

		A	B	C	D	E	F	G	H

Icing conditions	**-18**	-	-	-	-	-	-	-	-
	-22	-	-	-	-	-	-	-	-

As seen in Table 5, no icing was observed at -18 and -22 degrees. It has been determined that the herbal solutions do not freeze for a week at -18 and -22 degrees. In addition, it was observed that these solutions did not freeze when kept in the same environment for a month. With this feature, it is thought that it will help to prevent new icing in the applied area.

Figure 6: Condensation rates of solutions at -18 ^{0}C



As can be seen in Figure 6, the flow rates of 8 different solutions at -18 degrees are indicated.

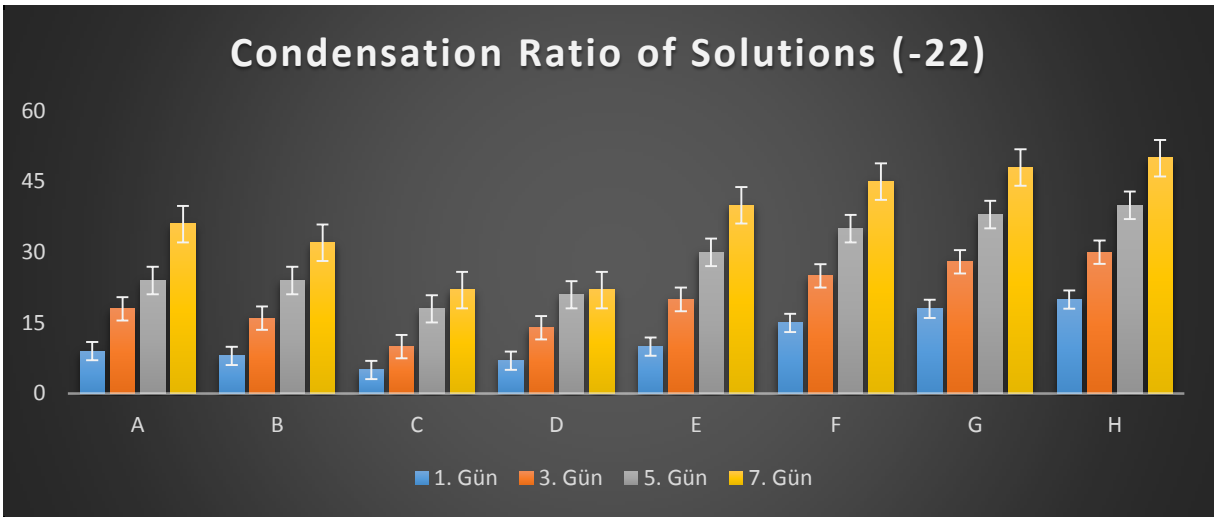


Figure 7: Condensation rates of solutions at -22 ^{0}C are indicated.

As can be seen in Figure 7, the flow rates of 8 different solutions at -22 degrees are indicated.

Condensation, that is, the high solution fluidity, prevents the adhesion in the application area and the contact with the cold air by covering the surface. It has been determined that with this feature, it prevents the ice remaining on the bottom surface from melting and re-icing. With this feature, it is thought that accidents and loss of life caused by hidden icing will decrease.

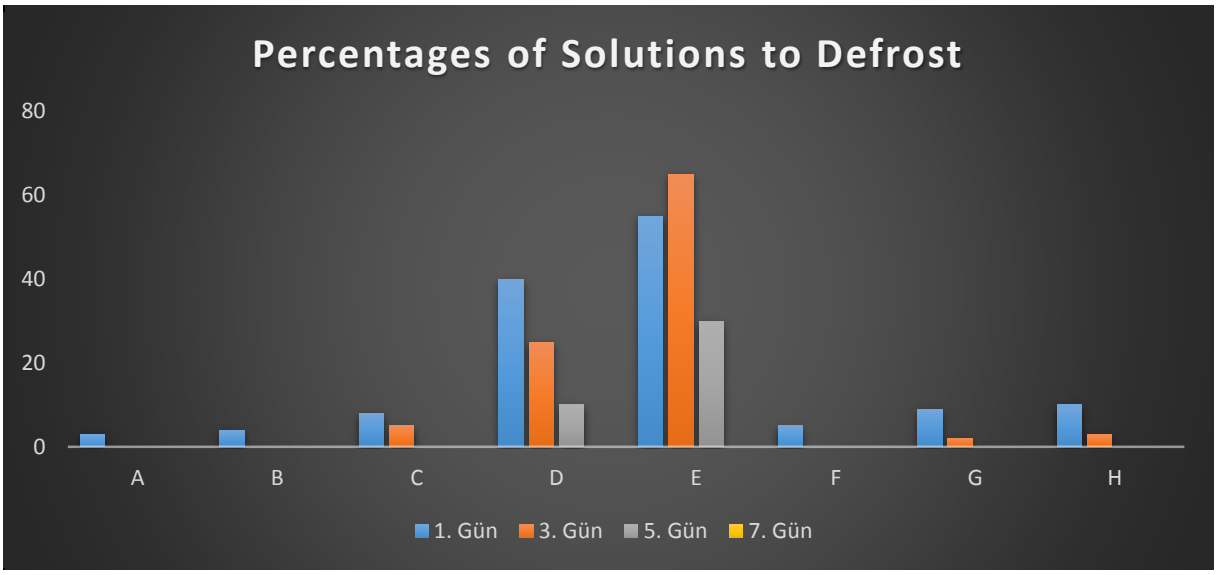


Figure 5: Percentage of solutions melting ice

As can be seen in Figure 5, the percentages of ice melting of 8 different solutions at -18 degrees are indicated.

According to a study, it has been determined that low carbon steel used in asphalt is corroded in 3.5% NaCl environment [26]. In order to prevent snow and icing, 2.5% salt solution decreased the stiffness modulus of concrete asphalt pavements by 35% and fatigue strength by 41% [27,28]. While the increase in the amount of salt used dissolves the ice, it damages a metal component such as asphalt structure, road signs and cars. In this process, we need to both protect the environment and facilitate the lives of living things by preventing icing. The obtained E solution showed 65% melting success under long-term (-180C) severe cold. Frosts of the same intensity are not observed in nature all the time. At the same time, these calculations were calculated by ignoring the pressure created by the vehicles on the ice. When this factor is added, the success of the solution is expected to increase. Since salt production is high and cheap in our country, it is widely used to combat icing. Although its cost is calculated as reduced, it harms the environment, asphalt, concrete and metal parts. According to a study conducted in the USA, it has been calculated that the damage caused by a ton of salt to the environment is 800 dollars, and this will cause a loss of 100 million dollars per year to the US economy [29]. It has been determined that this solution does not damage metal parts. The high organic matter ratio of molasses used in the solution is expected to positively affect the development of living things in the environment.

RESULT AND DISCUSSION

Beet juice, which is known to be harmless to the environment, also has a positive contribution to the root development of plants. A. vera plant shows resistance to cold with its protection mechanism. When the same protection mechanism is combined with beet juice, its effect against hidden icing has been investigated.

In order to prevent hidden icing, 3 different applications were made to 8 different solutions. With this research, it is aimed to obtain an economical, environmentally friendly and recycling-based solution that tries to prevent accidents caused by hidden icing.

In order to reduce the freezing temperature of the water to -9 0C, 29 g of NaCl is dissolved in 100 ml of water. Considering the harm of excess salt to the environment, the salt ratio was

reduced and the temperature was lowered to -22 0C. Solution contents were determined by considering these properties. The changes of 8 different solutions determined against latent icing were determined.

At -18 0C, beet juice + 10 g NaCl (D) on the 1st and 3rd days, and beet juice + 5 g NaCl (C) on the 5th and 7th days shows the lowest ratio in terms of density. As seen in Chart 1, the general order was observed as A-E-F-G-H for 7 days. On the 1st, 3rd, 5th and 7th days at -22 0C, the density order is listed as C-D-B-A-E-F-G-H as seen in chart 2. Common results were obtained at both temperatures. While an increase in density was observed in the solutions, icing was not observed at all.

Eight different solutions were applied to the icy area. E and C of the applied solutions were effective. However, as a result of the application, it was determined that the melting rate of the ice decreased towards the 7th day. These results were obtained in the laboratory environment and were found by ignoring the force exerted by the vehicles on the ground. It is thought that the percentage of success will increase when the force to be applied by the tools is added.

Accordingly, it is thought that the success will increase as a result of the pre-application of the solution to the areas with the danger of hidden icing. It gave a positive response to latent icing in 8 different solutions produced. However, in terms of environmental friendliness, cost and efficiency, beet juice + 5 g NaCl (C) solution gave more successful results. In addition, it is thought that the application can be done with irrigation tools and the cost will decrease with less workers. Due to the high damage caused by salt to the environment, new methods should be used now. While looking for such natural solutions, studies can be carried out on plant species that prevent the freezing of plant internal water while protecting itself against cold stress in nature. It is thought that researches on environmentally friendly solutions should increase.Present your conclusions here. If you use any references, these should be numbered in the order in which they appear in the text. In the text, enclose reference numbers in square brackets, e.g. [1], [2], [3], … etc. That means that references should not be listed in alphabetical order. Journal articles as depicted in the example below should conform to the standard Vancouver style of punctuation, and abbreviations. Finally, please ensure that you keep within the word limits. The text of your paper should not be exceeded 20 pages (including figures, tables and references).

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