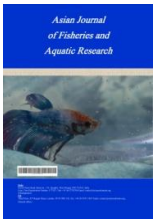

Asian Journal of Fisheries and Aquatic Research

13(6): 10-18, 2021; Article no.AJFAR.72578
ISSN: 2582-3760

Effect of the Addition Red Ginger Extract (*Zingiber officinale* Var Rubrum*)* on the Physical and Microbiological Characteristics of Seaweed Jelly Candy

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJFAR/2021/v13i630280
Editor(s):
(1) Dr. Pınar Oguzhan Yildiz, Ataturk University, Turkey.
Reviewers:
(1) Wafai Z. A. Mikhail, Cairo University, Egypt.
(2) Zahra Khoshnood, Islamic Azad University, Iran.
Complete Peer review History: https://www.sdiarticle4.com/review-history/72578

Original Research Article

Received 02 June 2021
Accepted 09 August 2021
Published 12 August 2021

ABSTRACT

Seaweed jelly candy is a popular food product with a characteristic chewy texture and sweet taste, but it is very susceptible to quality degradation because it is semi-wet so it is easy for microorganisms to grow. This research aims to determine the effect of adding red ginger extract on the physical and microbiological characteristics of seaweed jelly candy. The research method used is an experimental method with four treatments with three replications adding concentration of red ginger extract (0%, 20%, 35% and 50%) based on the weight of the seaweed used. The parameters observed in this research are physical characteristics (*Texture Profile Analysis* / TPA) and microbiological characteristics which include, gumminess, gel strength, adhesiveness, springiness, cohesiveness, chewiness and total mold. Total mold testing was carried out using the duplo method and referring to SNI 2332.07 in 2009. Texture Profile Analysis/ TPA testing was carried out using Completely Randomized Design (CRD). Based on the research results, it can be concluded that the addition of red ginger extract has an effect on the physical and microbiological

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characteristics of seaweed jelly candy. The best treatment with addition of red ginger extract to the physical and microbiological characteristics of seaweed jelly candy is treatment D (addition of red ginger extract 50%), with gumminess value of 128.87%, gel strength 468.26 gforce, adhesiveness -0.053%, springiness 0 .83%, cohesiveness 0.16%, and chewiness 107.75%, and the total value of mold is 2.46.

Keywords: Jelly candy; microbial characteristic; red ginger extract; seaweed; physical characteristic.

1. INTRODUCTION

Seaweed is one of the export commodities of Indonesian waters that have the potential to be developed due to high market demand [1]. Indonesia became the second largest country after China in seaweed production in 2013, which was 34% of the world's total seaweed production of 26,896,004 tons [2]. According to the Marine and Fisheries Ministry performance report data in 2016, the seaweed cultivation area is 1.1 ha, which is 9% of the total marine aquaculture land, however, its use is still 25% [3]. Seaweed production in Indonesia is 16.17 million tons, with export value increasing by 16.69% in the 2016-2017 periods with export volume reaching 192 thousand tons [4].

Seaweed commonly used in the processing industry is seaweed from the Rhodophyceae group. Several types of seaweed belonging to Rhodophyceae are Gracillaria sp., Gellidium sp., Gellidiela sp., and Gellidiopsis sp. is a producer of agar and Euchema sp. which is a carrageenan producer [5]. Eucheuma cottonii is one of the seaweeds that are often used as food [6].

The use of Eucheuma cottonii as a food product in Indonesia is still very limited, even though this seaweed contains ingredients that are rich in dietary fiber which is good for human health [7]. The content of dietary fiber and its nutrition is useful as an antioxidant, ant-mutagenic, ant-coagulant, ant-tumor, and lipid metabolism [8].

Candy or confectionery is one type of sugar-based food that is favored by many people from various circles, due to the variety of flavors, colors and shapes.

Jelly candy is a soft textured confectionery, processed with the addition of hydrocolloid components such as agar, gum, pectin, starch, carrageenan, gelatin and others which are used for texture modification to produce a chewy product [9]. Seaweed jelly candy one of the diversified products of processed seaweed, this is because seaweed contains hydrocolloids, namely carrageenan which functions as a thickener of candy jelly.

Seaweed jelly candy one of the potentials that can be widely developed, as an alternative processed from seaweed which is still often marketed in the form of raw/raw materials. However, seaweed jelly candy is a food product with a distinctive chewy texture and as a semi-wet food product that is susceptible to overgrown with molds.

Red ginger is one of the spices that are easily found in Indonesia, but its use for food products is still very limited, such as being used as a base for candy [10]. According to research, red ginger contains starch (52.9%), more essential oils than other types of ginger, namely (3.9%) [11]. Red ginger also contains various secondary metabolites such as flavonoids, tannins and saponins [12]. Utilization of red ginger in food production is generally carried out in the form of red ginger extract, either dry extract or liquid extract.

Red ginger extract containing starch as one of the hydrocolloid ingredients is expected to improve the texture of seaweed jelly candy [11]. In addition, secondary metabolites contained in red ginger such as essential oils, flavonoids, tannins and saponins can be used as inhibitors of mold growth in seaweed jelly candy [12].

Therefore, it is necessary to study the impact of the addition of red ginger extract into seaweed jelly candy which can improve the texture or physical characteristics of seaweed jelly candy and to inhibit the growth of mold in seaweed jelly candy.

2. MATERIALS AND METHODS

2.1 Time and Place

This research was conducted from December 2020 to January 2021 at the Fishery Products Processing Laboratory, Building 2, Faculty of Fisheries and Marine Sciences, Padjadjaran University, and the Test Services Laboratory,

Faculty of Agricultural Industrial Technology, Padjadjaran University.

2.2 Materials and Tools

Materials used in the study were dried seaweed *Eucheuma cottonii*: Solieriaceae obtained from Pasar Kemis Tangerang Banten, red ginger (*Zingiber officinale* var Rubrum) obtained from Bogor Regency, water, sugar brand Gulaku, Potato dextrose agar (PDA) brand Merck, and physiological NaCl 0.85%. The tools used are basin, blender, petri dish, measuring cup, knife, filter, scale, test tube, stove, baking sheet, spatula, bowl, pocket thermometer, frying pan, incubator, ose needle, pipette, texture analyzer (TA-XTexpress), oven, porcelain dish, charcoal paper, and Erlenmayer flask.

2.3 Research Methods

Methods used in research on making seaweed jelly candy with the addition of red ginger extract is the experimental method using a completely randomized design (CRD) with 4 treatments and 3 replicates adding different concentration of red ginger extract (0%, 20%, 35% and 50%) based on the weight of the seaweed These concentrations used based on previous study., used.for testing physical characteristics, namely the test Texture Profile Analysis (TPA) on seaweed jelly candy. The method used in testing the microbiological characteristics using the experimental method with four treatments adding different concentration of red ginger extract (0%, 20%, 35% and 50%) based on the weight of the seaweed.

2.4 Research Procedure

2.4.1 Procedure for making red ginger extract

The procedure for making red ginger extract refers to [10]. The red ginger rhizome is cleaned from the skin. Then the peeled red ginger rhizome is washed thoroughly, and sliced thinly. The ginger rhizome is blended with the addition of water (1:1). The red ginger extract was filtered using a stainless.sieve Red ginger extract is separated based on each required concentration.

2.4.2 Total mold testing procedure

The procedure for total mold testing on seaweed jelly candy is carried out based on SNI 2332.07 of 2009 concerning testing the number of molds and yeasts in fishery products [13], as follows: A total of 10 grams of sample that was mashed first, dissolved into in a test tube containing 90 ml of 0.85% NaCl solution (physiological/graphic salt solution) to obtain a dilution of 10^{-1}. A total of 1 ml of the solution was pipetted, then put into a test tube which already contained 9 ml of physiological saline solution to obtain a dilution of 10^{-2} until a dilution of 10^{-5}. From each dilution test tube, 1 ml was taken using a pipette, put into a sterilized petri dish. Each dilution was carried out in duplicate. Then each cup is moved in a circle on the table so that the PDA media is evenly distributed. After the PDA freezes, the petri dishes are incubated in an incubator for 48 hours at a temperature of 27℃, the petri dishes are placed upside down. After the incubation period, the colonies growing on the petri dishes are counted by the acceptable number of colonies 1×10^{2} colony/g.

2.5 Data Analysis

The data from the texture profile analysis (TPA) test used the *analysis of variance* (ANOVA) test or the F test and continued with the least significants difference (LSD) test if the calculated F was significantly different from the F table . The data from the observation of microbiological characteristics were analyzed by comparative descriptive method.

3. RESULTS AND DISCUSSION

3.1 Physical Characteristics (Texture Profile Analysis/ TPA) Seaweed Jelly Candy

3.1.1 Gumminess

The results of calculating the value of gumminess in seaweed jelly candy with the addition of red ginger extract are presented in Table 1.

Based on the results of the research, the average value of the highest gumminess was in treatment D with the addition of red ginger extract as much as 50% has an average gumminess value of 128.87%. Treatment C with the addition of red ginger extract as much as 35% has a gumminess value of 117.59%. Treatment B with the addition of red ginger extract as much as 20% had an average gumminess value of 110.08%, while the smallest value in treatment A without the addition of red ginger extract had an average elasticity value of 101.31%.

The addition of red ginger extract with higher concentrations increased the average value of the gumminess of the jelly candy. Gumminess is a characteristic that is largely determined by the thickening agent or gelling agent used which is known as a hydrocolloid material. Gumminess is a very important characteristic of seaweed jelly candy, because the characteristic of jelly candy is its gumminess. The starch content in red ginger affects the level of elasticity of the jelly candy produced, so the higher the concentration added, the higher the elasticity produced because the starch contained in the red ginger extract is higher.

Samples of seaweed jelly candy of commercial have a gumminess value of 153.57%. This gumminess value is higher when compared to the average value of the gumminess of the sample of seaweed jelly candy in the research results. Treatment D with the addition of 50% red ginger extract had the gumminess value closest to the results of the sample seaweed jelly candy commercial, which was 128.87%. Treeatment D is the best treatment for adding red ginger extract to the gummines characteristics of seaweed jelly candy.

3.1.2 Bloom Strength

The results of the calculation of bloom strength on seaweed jelly candy with the addition of red ginger extract are presented in Table 2.

Based on the research results, the highest average bloom strength value in treatment A was without the addition of red ginger extract with a bloom strength value of 480,617 gf, then followed by treatment D, namely the addition of 50% red ginger extract of 468.257 gf, treatment C with the addition of 35% red ginger extract of 260.517 gf, and the lowest was in treatment B with the addition of 20% red ginger extract with a value of 143.8 gf.

Treatment A without the addition of red ginger extract had the highest average bloom strength value when compared to jelly candy with red ginger extract added. This could be due to the fact that when the seaweed slurry was heated at a temperature of 95℃, the carrageenan contained inthe seaweed Eucheuma cottonii as a gelling agent was formed. The water content is less in treatment A because it is not added with red ginger extract which also contains water, causing the gel formed to be stronger. Because each treatment is heated at the same temperature and time the gel strength of treatment A have the highest value. In treatments B, C and D, the gel strength was weaker due to the added water content of the red ginger extract.

Based on observations, the addition of red ginger extract in treatments B, C and D, increased the value of the bloom strength of the seaweed jelly candy but did not give a significant effect. The increase in bloom strength could be due to the fact that the fresh red ginger used in the manufacture of jelly candy contains quite high starch. Red ginger contains 52.1% starch [11]. Starch is one of the hydrocolloid components that play a role in gel formation. Starch is composed of amylose and amylopectin components. Amylose plays a role in the formation of a strong gel [14].

The jelly candy sample commercial obtained from micro, small and medium enterprises (MSME) Cottoni Panrita Makassar has a bloom strength value that is much higher than the bloom strength value in the research sample, which is 2421.10 gf. The high bloom strength of jelly candy samples commercial when compared with candy *jelly* research can be caused by different types of raw materials used or different heating methods. According to information obtained from MSME owners, the type of seaweed used, namely *Eucheuma cottonii* is same as that used in the research. The difference in the high level of bloom strength can be caused by the type of sugar used or the heating time and temperature.

Table 1. Average Value of Gumminess Seaweed Jelly Candy

NO.	Treatment	Average (%)
1.	A (0%)	101.31a
2.	B (20%)	110.08a
3.	C (35%)	117.59a
4.	D (50%)	128.87a
5.	K (Commercial)	153.57

Note: The same letter notation shows no significant difference between treatments according to the LSD Advanced Test with a test level of 5%

Table 2. Average Value of Bloom Strength Seaweed Jelly Candy

NO.	Treatment	Average (%)
1.	A (0%)	480.62a
2.	B (20%)	143.80a
3.	C (35%)	260.52a
4.	D (50%)	468.26a
5.	K (Commercial)	2421.10

Note: The same letter notation shows that there is no significant difference between treatments according to the LSD Advanced Test with a test level of 5%

Table 3. Average value of Adhesiveness Seaweed Jelly Candy

No.	Treatment	Average (%)
1.	A (0%)	-0.027a
2.	B (20%)	-0.010a
3.	C (35%)	-0.003a
4.	D (50%)	-0.053a
5.	K (Commercial)	-0.010

Note: The same letter notation shows that there is no significant difference between treatments according to the LSD Advanced Test with a test level of 5%

3.1.3 Adhesiveness

The result calculation of adhesiveness on seaweed jelly candy with the addition of red ginger extract is presented in Table 3.

Based on the research results, the highest average value of adhesiveness is in treatment C with the addition of 35% red ginger extract which has a adhesiveness value of -0.0033 %. Treatment B with the addition of 20% red ginger extract had a adhesiveness value of -0.01%. Treatment A without the addition of red ginger extract had a adhesiveness value of -0.0267%. The lowest adhesive value was in treatment D with the addition of 50% red ginger extract which had a adhesiveness value of -0.053%

The addition of red ginger extract into seaweed jelly candy increased the adhesiveness value of the jelly candy until the addition of red ginger extract by 35%. Meanwhile, the addition of red ginger extract as much as 50% had the smallest adhesiveness value. This means that the addition of red ginger extract as much as 35% is the optimal value for the addition of red ginger extract to the adhesiveness characteristics of jelly candy.

The commercial sample of jelly candy has a adhesiveness value of -0.01%, this value is the same as in the research sample with the addition of 20% red ginger extract. So when compared, the best treatment on the adhesiveness characteristics of jelly candy is the best in treatment B with the addition of 20% red ginger extract because it has the same value as commercial samples that have passed the Indonesian National Standard test. The higher the negative area produced in the test explains that the product seaweed jelly candy produced has the highest adhesiveness value.

3.1.4 Springiness

Results calculated value of springiness on seaweed jelly candy with the addition of red ginger extract is presented in Table 4.

Table 4. Average Power Value Lenting or Springiness seaweed jelly candy

NO.	Treatment	Average (%)
1.	A (0%)	0.84a
2.	B (20%)	0.6a
3.	C (35%)	0.95a
4.	D (50%)	0.83a
5.	K (Commercial)	0.84

Note: The same letter notation shows that there is no significant difference between treatments according to the LSD Advanced Test with a test level of 5%

Based on the research results, the average value of the springiness of jelly candy with the addition of red ginger extract is the highest in treatment C with the addition of red ginger extract 35% has the highest average springiness value of 0.947%, then followed by treatment A, which is without the addition of red ginger extract of 0.843%. Treatment D with the addition of red ginger extract as much as 50% has an average value of springiness of 0.83, then the smallest average value of resilience in treatment B with the addition of red ginger extract as much as 20% with an average value of springiness of 0 ,6%.

The average value of springiness in the research results showed an increase in the value of springiness in treatments B and C, from 0.6% to 0.947%. However, in treatment D with the addition of red ginger extract as much as 50% the average springiness value decreased to 0.83%. The addition of red ginger extract to a concentration of 35% increased the springiness value to the optimum point. However, when compared with the value of resilience in commercial samples, the value of springiness in treatment C with the addition of red ginger extract as much as 35% has a much higher value.

The commercial sample of seaweed jelly candy obtained from MSME Cottoni Panrita has a springiness value of 0.84%, this value is almost the same as the sample in treatment A, without the addition of red ginger extract with a springiness value of 0.843%. Treatment D with the addition of red ginger extract as much as 50% has a springiness value of 83%, this value is almost close to the value of the sample jelly candy commercial, so that treatment D is the best treatment with the addition of 50% red ginger extract on the springiness characteristics because it is close to the value springiness in commercial samples.

3.1.5 Cohesiveness

The results calculation cohesiveness on seaweed jelly candy with the addition of red ginger extract is presented in Table 5.
Based on the research results, the highest average cohesiveness value is in treatment A without the addition of red ginger extract with a value of cohesiveness 0.19%, then in treatment D with the addition of red ginger extract as much as 50% has an average value of 0.16% cohesiveness. Treatment B with the addition of red ginger extract as much as 20% has an average cohesiveness value of 0.14%, and the lowest cohesiveness value is in treatment C with the addition of red ginger extract as much as 35% has a cohesiveness value of 0.11%.

The addition of red ginger extract had no effect on the cohesiveness characteristics of the seaweed jelly candy. The cohesiveness of the jelly candy without the addition of red ginger extract had a higher average value than the jelly candy added with red ginger extract. The addition of red ginger extract 35% and red ginger extract 50% increased the average value of cohesiveness. However, the treatment with the addition of 20% red ginger extract had a higher average cohesiveness value than the addition of 35% red ginger extract. The cohesiveness of jelly candy is affected by heating time and temperature. The longer the heating time and the higher the temperature used, the higher the cohesiveness value will be because the water content in the product will be increasingly bound by the sugar components used.

Commercial samples of seaweed jelly candy has an cohesiveness value of 0.29%. The treatment without the addition of red ginger extract, namely in treatment A, was the treatment that had the closest cohesiveness average value to the sample jelly candy commercial. The treatment with the addition of red ginger extract closest to the results of the commercial jelly candy, namely in treatment D with the addition of red ginger extract as much as 50% had an average cohesiveness value of 0.16%.

3.1.6 Chewiness

The results of the calculation of the value of chewiness on seaweed jelly candy with the addition of red ginger extract are presented in Table 6.

Based on the research results, the average value of chewiness in treatment C with the addition of red ginger extract is 35% has the highest value of chewiness that is equal to 113.7%, treatment D with the addition of red ginger extract as much as 50% has an average value of 107.75% chewiness. Treatment A, without the addition of red ginger extract, had an average chewiness value of 91.67%, while treatment B with the addition of 20% red ginger extract had the smallest chewiness value of 74.29%.

Table 5. The average value of Cohesiveness Seaweed Jelly Candy

NO.	Treatment	Average (%)
1.	A (0%)	0.19a
2.	B (20%)	0.14a
3.	C (35%)	0.11a
4.	D (50%)	0.16a
5.	K (Commercial)	0.29

Note: The same letter notation shows no significant difference between treatments according to the LSD Advanced Test with a test level of 5%

Table 6. The Average Value of Chewiness Seaweed Jelly Candy

NO.	Treatment	Average (%)
1.	A (0%)	91.67a
2.	B (20%)	74.29a
3.	C (35%)	113.7a
4.	D (50%)	107.75a
5.	K (Commercial)	577.11

Note: The same letter notation shows no significant difference between treatments according to the LSD Advanced Test with a test level of 5%

The addition of red ginger extract from a concentration of 20% to 35% increased the chewiness value of seaweed jelly candy, but the addition of red ginger extract with a concentration of 50% had a lower chewiness value than the addition of 35% red ginger extract.

The sample of commercial seaweed jelly candy has a chewiness y value of 577.11%, this value is much higher than the jelly candy sample in the research results. The closest results were jelly candy sample in treatment C with the addition of 35% red ginger extract. However, this result is still far below the chewiness value of commercial jelly candy obtained from MSME Cottoni Panrita Makassar. The difference in the value of chewiness of seaweed jelly candy with the addition of red ginger extract and commercial seaweed jelly candy can be caused by the quality of the raw materials, as well as the heating time and temperature used during the production jelly candy.

3.2 Microbiological Characteristics of Seaweed Jelly Candy

The results of total calculation of molds in seaweed jelly candy with the addition of red ginger extract are presented in Fig. 1.

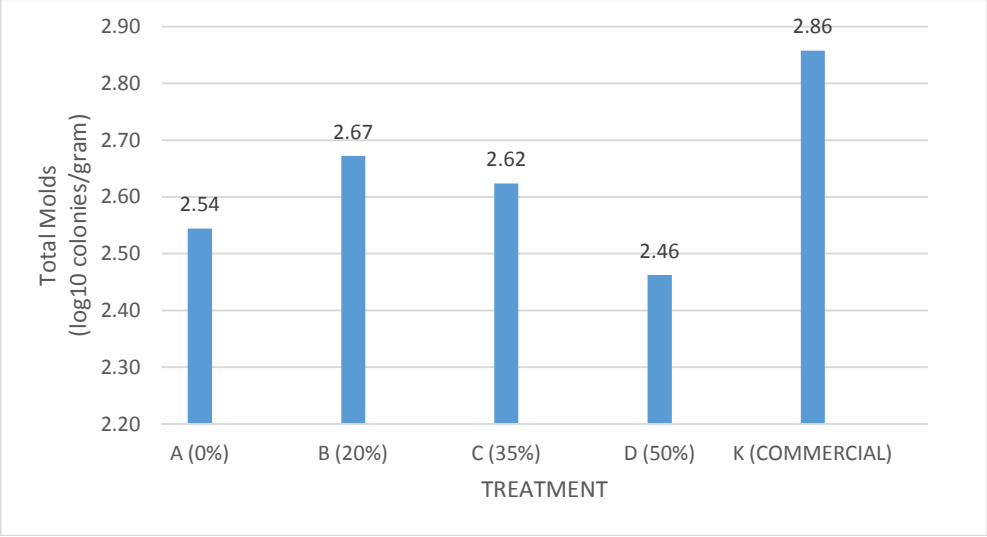

Fig.1. Mold Colonies in Seaweed Jelly Candy

Based on the results of the research, it showed that seaweed jelly candy in treatment D with the addition of 50% red ginger extract had the smallest total value of mold, which was 2.46. The obtained from MSME Cottoni Panrita in Sulawesi has a total number of mold that most high at 2.86. The calculation is done in duplicate.

Based on the above results, samples of seaweed jelly candy observed in accordance with Indonesia National Standard 3547.02-2008 yet, because it has a total of mold > 2. This shows that the addition of red ginger extract has no significant effect on the growth of molds in seaweed jelly candy [7], conducted a study of making seaweed jelly candy ginger-flavored with the addition of 50% ginger extract. the total identified microbes have met SNI 3547.02-2008 with a total colony of 2.39. while the research conducted with the addition of red ginger extract as much as 50% had a total of molds that were not in accordance with SNI 3547.02-2008 which was 2.46, in the treatment with the addition of 35% red ginger extract had fewer total molds of 2.62.

This can be caused by exposure to contamination from the environment in the seaweed jelly candy during the manufacturing process to drying. The process of making seaweed jelly candy that is not carried out aseptically is very possible for the entry of pollutants during the production of seaweed jelly candy until the time the mold testing is carried out. Drying seaweed jelly candy using direct sunlight can be the biggest cause of contamination because seaweed jelly candy during drying is in direct contact with the outside air. Contamination can come from dust carried by the wind or by the presence of organisms that perch on the surface of the seaweed jelly candy being dried. Molds can live freely and are widely distributed, sometimes cosmopolitan in the air [15]. In addition, spores from small molds are very easy to be carried by the wind through dust or from insect bodies.

The addition of red ginger extract in this study had no effect on the total growth of molds in candy. This seaweed jelly candy could be due to the fact that the concentration of red ginger extract given was not appropriate to prevent mold growth. Some plant extracts in the form of water extracts are effectively used as food preservatives with high concentrations (>10%) [16].

4. CONCLUSION

Based on the results of the research, it was concluded that the addition of red ginger extract affected the physical and microbiological characteristics of seaweed jelly candy. The best treatment with addition of red ginger extract on the physical and characteristics of microbiological seaweed jelly candy treatment D (addition of red ginger extract 50%), with a gumminess value of 128.87%, gel strength 468.26 gf, adhesiveness -0.053%, springiness 0.83%, 0.16% cohesiveness, and 107.75% chewiness, and the total value of mold is 2.46.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

All authors declare that ‘written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/72578