Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(5): 554-558
Received: 12-07-2020
Accepted: 03-08-2020

Swapna Sahoo
Department of Agriculture Processing and Food Engineering, College of Agricultural Engineering and Technology, OUAT, Odisha, India

Sneha Snigdha Sarangi
Department of Agriculture Processing and Food Engineering, College of Agricultural Engineering and Technology, OUAT, Odisha, India

Kalpana Rayaguru
Department of Agriculture Processing and Food Engineering, College of Agricultural Engineering and Technology, OUAT, Odisha, India

Corresponding Author:
Swapna Sahoo
Department of Agriculture Processing and Food Engineering, College of Agricultural Engineering and Technology, OUAT, Odisha, India

Effect of pretreatment on milling characteristics of little millets

Swapna Sahoo, Sneha Snigdha Sarangi and Kalpana Rayaguru

Abstract
Little millet, rich in nutritional and health promoting factors has not been commercially popular because of its difficult post-harvest operations. Experiments were conducted to study the effect of different pretreatment on dehulling characteristics of these small grains using an abrasive roller. The different unit operations used as pretreatment were soaking, parboiling followed by drying. Both sun drying and hot air convective drying at 45 ^{0}C were used prior to milling. Different milling performance indices were measured for all the samples subjected to different treatment methods and compared. The results indicated that the samples soaked for 4 h followed by hot air drying at 45°C had maximum dehulling and milling efficiency as 96.72% and 70.21% respectively. The head yield of the product was 53.32% with usable brokens as 16.88 % coarse and 3.25% fine fractions.

Keywords: Little millets, hydrothermal, dehulling efficiency, milling efficiency, brokens

1. Introduction
Little millet, *Panicum sumatrense* is native to India and is cultivated mostly in hilly areas. It has the ability to withstand both drought and water logging situations. It is one of the important millet crops in many tribal pockets in Odisha. These little millets are a powerhouse of nutrition, phyto-chemicals and have excellent antioxidant properties. It is reported that 100g grain contains about 67g of carbohydrate, 7.6 g of dietary fibers, 4.7 g of fat, and 7.7g of protein and is rich in B-vitamins, minerals like calcium, iron, zinc and potassium. Most of its nutritional values are higher with better quality as compared to those of rice and wheat [1, 2, 3]. The high dietary fiber content of little millet protects against hyperglycemia. It possesses low glycaemic value [4]. It reduces cholesterol and helps indigestion. Millets manage coronary diseases and sugar level, promotes digestion and helps in detoxification [5, 6, 7, 8]. Millets are also rich in phytochemicals and nutraceuticals [9].
The present pattern of consumption is mainly in the form of traditional preparations during special occasions. Its utilization is restricted to only certain cultural occasions in certain parts of the country. The nutritional composition of these grains is superior to those of other cereals both quantitatively and qualitatively. There is a huge scope for value addition of these grains to develop convenient food products using suitable process technology [10]. A number of value added products such as flakes, *dalia* and instant *kheer* mix etc have been developed by many research workers. Standardization of many modern day food products such as extruded products like pasta, noodles and bakery products have also been made. However, the commercial exploitation of these products has not been possible to a greater extent till date. This is mainly because of the lack of suitable post-harvest processing solutions for little millet [11]. The primary processing operations such as cleaning and grading of little millets are difficult to be carried out efficiently because of the size of the grain as limiting factor. Further, the dehulling of grain to remove the hull from the grain as the hull is tightly attached to kernel. Mostly these are processed in hand and leg pounding which is laborious and time consuming. This particularly, poses a lot of drudgery to women. Presently, some little millet grains are milled in the conventional rice huller mills which yields higher percent of brokens and loss of kernels in the hull as an admixture. Recently some millets processing machines have been developed which are specially designed for grains of small size. But these are mostly of general type for a range of small grains. Therefore, the machine performance needs to be studied with respect to a particular grain type. Loosening of hull can be facilitated with the use of hydrothermal treatment prior to dehulling as it is done in case of parboiled paddy [12]. It also reduces the nutrient losses during milling and cooking [13]. The information on the hydrothermal treatment on little millets is limited and its influence on hulling characteristics has not been reported so far. Keeping the above facts in view, the present study was undertaken to study the effect of the hydrothermal treatment conditions on hulling characteristics of little millet. An attempt has been made to test an abrasive huller for this purpose.

2. Materials and methods

2.1 Sample preparation

The little millets (*Panicum sumatrense*) were obtained from the local market, Berhampur, Odisha, India. The grains were cleaned by using sieves and aspirators to remove all foreign matter, broken and immature grains. All tests were conducted in the laboratory at an ambient temperature of about 30±2°C and relative humidity of 70–75% and the moisture content range of 11±0.5% (db) of little millets which is optimum for dehulling operations of minor millets are usually performed in this range [14]. The size dimensions were also used for selection of set of sieves for effective separation after dehulling.

2.2 Dehulling characteristics

2.2.1 Operating principle of abrasive huller

The raw material after going through a rigorous process of cleaning was subjected tothe dehuller for hull removal. In an abrasive type dehuller the grinding stone coated with carborundum is used for hull removal which rotates at a constant speed. The roller is covered with a casing maintained at a constant gap. The raw material passes through the hopper unto the grinding stone and the hull gets sheared or abrased off. A sieve is placed below the stone through which the powder gets separated and comes out of the outlet placed at the lowest height and the grain recovery i.e the combination of hull, dehulled and unhulled grains remaining above the sieve are subjected to aspiration by which the hulls are blown away through a pipe and collected through the side outlet. The remaining dehulled and unhulled grains are collected from front outlet.

2.2.2 Determination of performance indices

1. Percentage of grain recovery, %= $\frac{wt.of\ grain\ recovered}{weight\ of\ sample} \times 100$
2. Percentage of hull, %= $\frac{wt.of\ hull}{weight\ of\ sample} \times 100$
3. Percentage of powder, %= $\frac{wt.of\ powder}{weight\ of\ sample} \times 100$
4. Dehulling efficiency(η), %= $\frac{weight\ of\ sample - wt.of\ unhulled}{weight\ of\ sample} \times 100$
5. Percentage of dehulled, %= $\frac{wt.of\ grain\ recovered - wt.of\ unhulled}{weight\ of\ sample} \times 100$
6. Percentage of head yield, %= $\frac{wt.of\ dehulled\ whole\ grain}{weight\ of\ sample} \times 100$
7. Percentage of coarse broken, %= $\frac{wt.of\ coarse\ grain}{weight\ of\ sample} \times 100$
8. Percentage of fine broken, %= $\frac{wt.of\ fine\ grain}{weight\ of\ sample} \times 100$
9. Coefficient of wholeness kernel= $\frac{weight\ of\ whole\ kernel}{weight\ of\ dehulled}$
10. Milling efficiency, %= $\frac{coefficient\ of\ wholeness\ kernel \times dehulling\ efficiency}{100}$

2.3 Pretreatment procedure

2.3.1 Hydrothermal treatment: It consisted of soaking and steaming prior to drying. Clean samples weighing 5kg of little millet (whole grains) were soaked in water in a container at a 1:3 ratio (v/v) for 2 to 4 hours and then drained. These drained grains were then dried by different methods. For parboiling the soaked grains were subjected to steaming in a traditional steamer. The steaming time was 15 minutes and the steaming temperature of 100°C was maintained [15].

2.3.2 Drying condition: The steamed little millet grains were dried in a hot air tray dryer (HAD) at 45°C for 4–6 hours until the moisture content was reached to 11±0.5% (db) and got stabilized. Dried samples were stored in moisture proof polythene bags for further study. The soaked little millets were also sun dried before milling. The effects of soaking time (2 and 4 h) and steaming condition on milling quality were investigated. A total of 5 treatment combinations along with the raw samples as control was tested for standardization of best treatment of little millet in order to achieve the maximum milling quality.

2.4 Experimental procedure for dehulling

The dried grains were passed through carborundum coated abrasive roller mill (INDOSAW, India). The machine had three outputs containing hull, powder and dehulled grain component. Dehulled grains were then subjected to sieving for further separation to obtain unhulled and coarse and fine (semolina) fractions of dehulled grains. The whole kernel grains were separated from brokens. The whole kernel yield consisted of kernels having more than three-fourth size of whole kernel. The per cent whole kernel yield (WKY) was calculated as whole milled grains with respect to total sample fed. The average value of triplicates was considered as final result. Percent coarse brokens were calculated as broken grains with size less than 3/4th of the whole milled grains with respect to total sample of grains fed. The detailed output fractions have been explained pictorially through a flow chart (Fig 1).

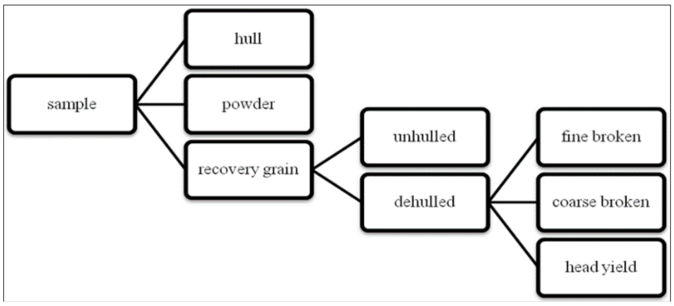


Fig 1: Flowchart of output fractions obtained from dehulling of little millets

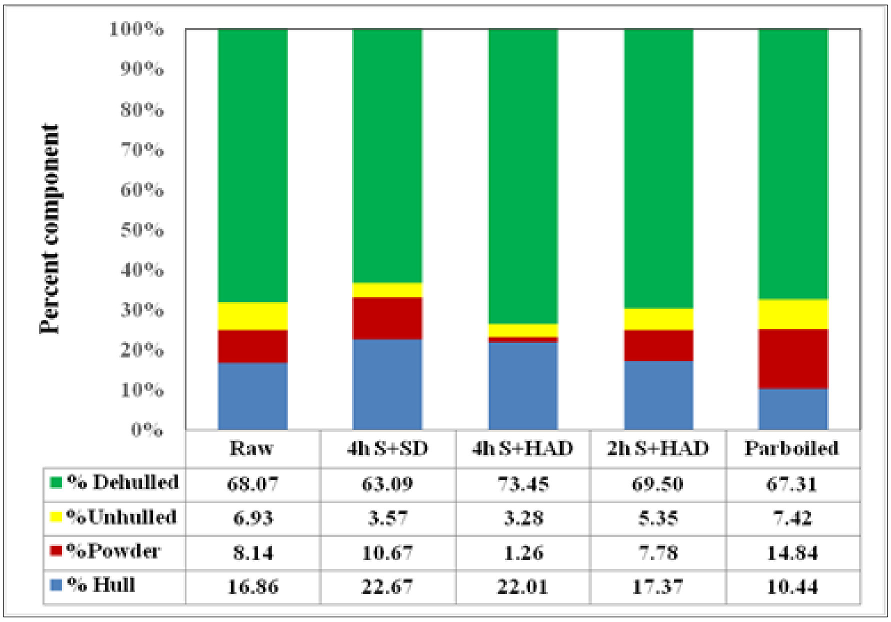
2.5 Standardisation of sieves for separation

As discussed in above sections a number of usable fractions are obtained from the milling of little millet. Therefore, standardisation of sieve type and size is difficult due to variations in grains of the same type and we may need customized sieves. A set of standard sieves sizes which are available commercially has been collected. Considering the sizes of treated unhulled samples, dehulled kernels, coarse and fine fractions, a set of standard sieves have been selected for effective separation of each desirable component which has been presented in results.

4. Results and discussion

4.1 Effect of pretreatment on dehulling characteristics

As discussed earlier, the raw and four treated samples were subjected to roller dehuller to have three outputs i.e., hull, powder and grain recovery which is presented in Fig1. The hull fraction represented mostly the separated hull from dehulled kernels. The grain recovery was separated into dehulled and unhulled components as reflected in the same figure. The hull percentage varied from minimum 10.44 % (parboiled) to maximum 22.67 % in samples soaked for 4 h followed by sun drying (Fig 2). Except the parboiled one, the rest of the samples did not show much variation in hull percentage. On the contrary, a large variation in powder percentage was observed with minimum of 1.26% for sample (4 h soaking with hot air drying) to 14.84 % in parboiled sample. This could be because of mixing of some kernel powder along with the hull powder due to excessive abrasion during operation. The possibility of this happening was probably due to the increase in dimension of grains during parboiling. The sundried soaked samples had both higher hull% and powder % indicating excessive breakage which may be due to non uniform drying. Out of grain recovery, the unhulled percentage was found to be least in sample soaked for 4 h followed by hot air drying and was highest in parboiled sample. Therefore, corresponding dehulled grain percentage was in the reverse sequence. It is inferred from the analysis of the outputs obtained from the roller dehuller that the samples soaked for 4 h followed by hot air drying at 45°C had minimum powder percentage (1.26 %), minimum unhulled (3.28 %) and maximum dehulled kernels (73.45 %) as grain recovery.



	Raw	4h S+SD	4h S+HAD	2h S+HAD	Parboiled
% Dehulled	68.07	63.09	73.45	69.50	67.31
%Unhulled	6.93	3.57	3.28	5.35	7.42
%Powder	8.14	10.67	1.26	7.78	14.84
% Hull	16.86	22.67	22.01	17.37	10.44

Fig 2: Effect of pretreatment method on dehulling yield

Fig 3 gives the detailed dehulled kernel fractions as whole, coarse and fine broken fractions with respect to weight of sample fed for all the treated and raw samples. It is observed that the 4 h soaked sample with hot air drying had highest whole kernel recovery (53%) followed by raw sample (48.78%). Rest three samples had almost comparable results. Sundried and 2 h soaked sample had higher breakage which may be due to either non uniform drying or incomplete soaking resulting in improper dehulling.

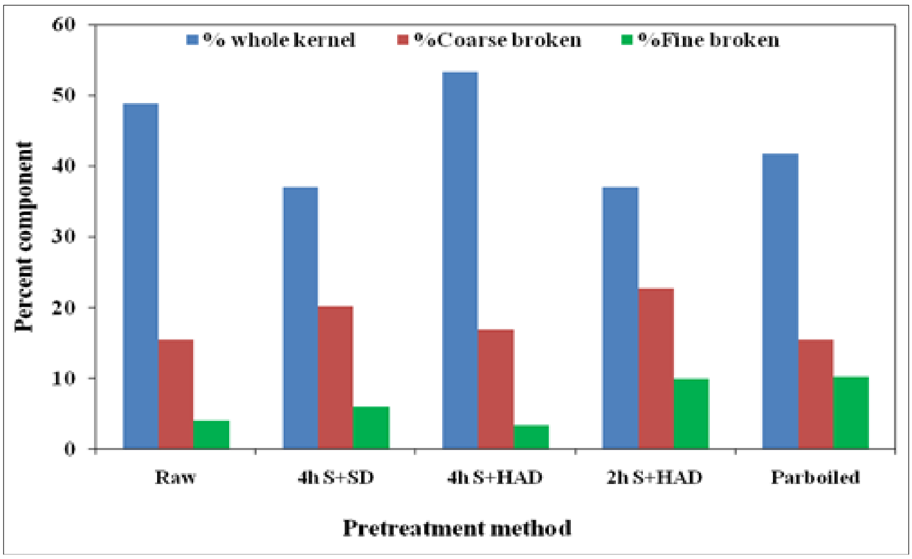


Fig 3: Effect of pretreatment on whole kernel, coarse and fine yield

Fig 4 depicts the overall milling efficiency of the system in terms of dehulling efficiency and coefficient of wholeness of kernel. Though all the fractions of kernels obtained were desirable, whole kernel is the most desirable component. Dehulling efficiency was found to be maximum (>96%) in 4 h soaked samples (both sun and hot air dried) which may be due to the fact that the complete soaking followed by drying could loosen the hull resulting in easy removal of hull. With increase in soaking time, the dehulling efficiency was increased. However, the coefficient of wholeness of kernel was less (58%) in sundried as compared to hot air dried sample (72.6%) having highest among all. This improvement may be due to increased binding effect of starch during drying. The reduced milling yield of parboiled rice may be due to higher size dimensions, longer duration of steaming and non adjustable gap between roller and casing. However, an improvement in performance indices of dehulling process may be brought in by increasing the number of passes through abrasive roller.

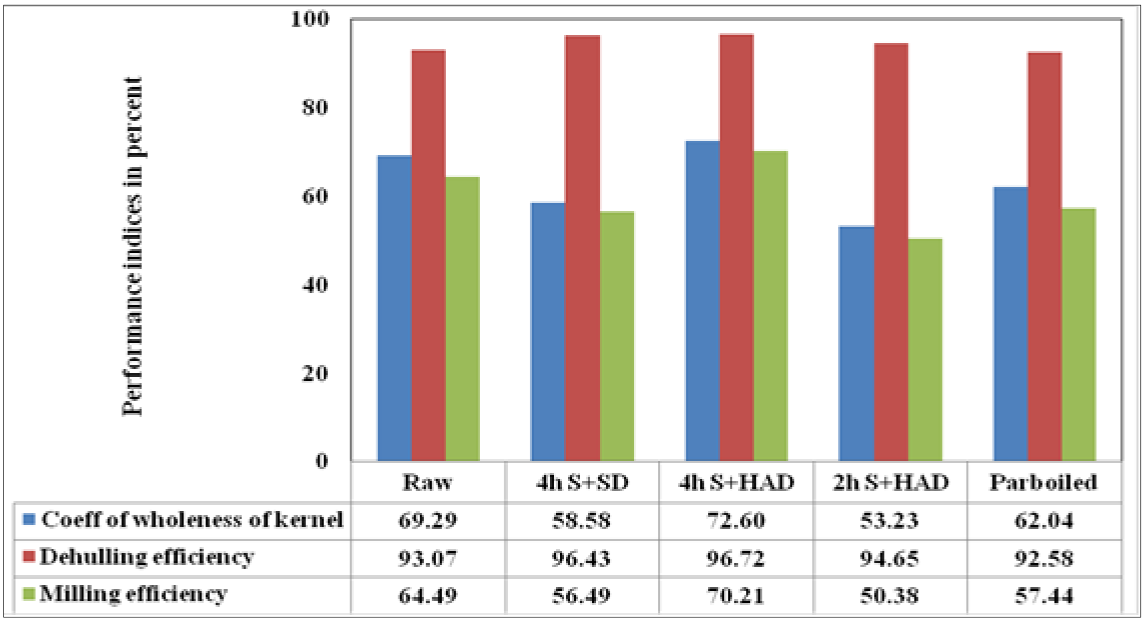


Fig 4: Effect of pretreatment on efficiency indices

3.2 Selection of standard sieves

During the process, it was observed that the separation of all components needs sieves of very precise mesh size. With the change in dimensions because of treatment, the sieve sizes need to be changed. Therefore, a set of commercially available sieves have been customised considering all possible fraction sizes in order to achieve an effective separation (Fig 5). Further, a precise separation of output may be achieved by using more number of sieves starting from a mesh size of 8 to 35 appropriately.

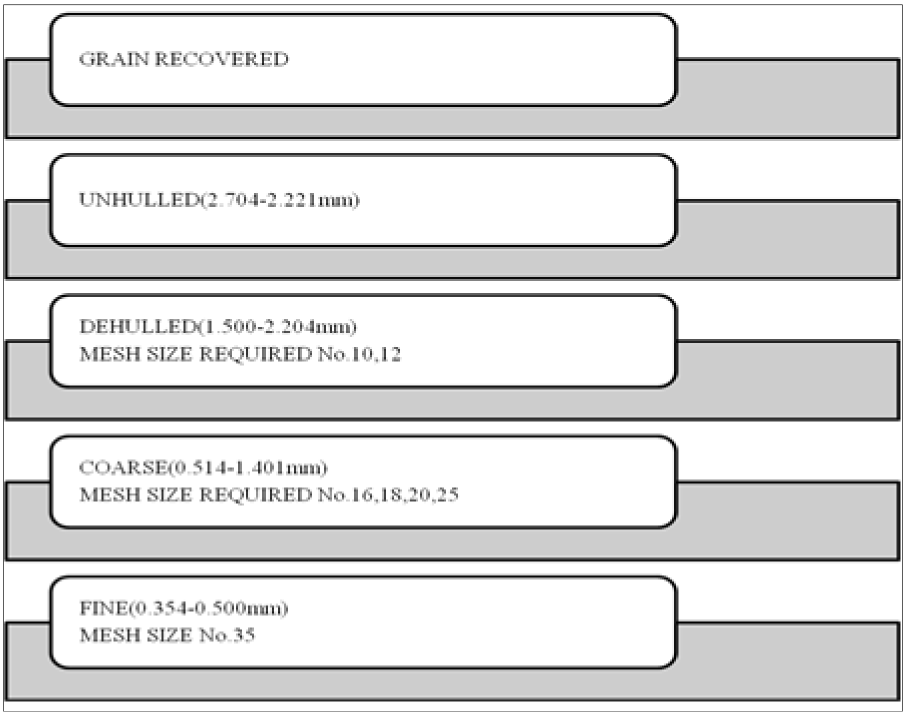


Fig 5: Standardisation of sieve sets

4. Conclusion

It is inferred from the outputs obtained from the roller dehuller that the samples soaked for 4 h followed by hot air drying at 45°C had minimum powder percentage (1.26 %), minimum unhulled grains (3.28 %) and maximum dehulled kernels (73.45 %) as grain recovery. Overall analysis of the dehulling cum separation process indicated that the dehulling efficiency (96.72%) and the milling efficiency (70.21%) of the dehulling process was maximum for the little millet sample subjected to 4 h soaking followed by hot air drying at 45°C. This sample could generate usable output as 53.32% whole kernel, 16.88 % coarse broken and 3.25% fine broken with 3.78 % unhulled millets.

5. Acknowledgments

The authors gratefully acknowledge the support provided by Odisha University of Agriculture and Technology, Bhubaneswar, India for carrying out the present research work.

6. References

1. Kotagi K, Chimmad B, Itagi S, Bharati P. Glycemic index and quality evaluation of ready to cook little millet (*Panicum miliare*) flakes. Proc international workshop on small millet research in value addition, IDRC, UAS, Dharwad (India). 2013; 8-9:94.
2. Chandrasekhara A, Naczk M, Shahidi F. Effect of processing on the antioxidant activity of millet grains. Food Chemistry. 2012; 133:1-9.
3. Kulkarni LR, Naik RK, Katarki PA. Chemical composition of minor millets. Karnataka Journal of Agricultural Sciences. 1992; 5(3):255-258.
4. Hadimani NA, Malleshi NG. Studies on milling, physico-chemical properties, nutrient composition and dietary fibre content of millets. Journal of Food Science and Technology. 1993; 30:45-52.
5. Sarita ES. Potential of Millets: Nutrients Composition and Health Benefits. Journal of Scientific and Innovative Research. 2016; 5(2):46-50.
6. Chethan S, Malleshi NG. Finger millet polyphenols: characterization and their nutraceutical potential. American Journal of Food Technology. 2007; 2(7):583-592.
7. Rao BR, Nagasampige MH, Ravikiran M. Evaluation of nutraceutical properties of selected small millets. Journal of Pharmacy and Bioallied Sciences. 2011; 3(2):277-279.
8. Bhat S, Nandini C, Tippeswamy V, Prabhakar. Significance of small millets in nutrition and health a review. Asian Journal of Dairy and Food Research. 2018; 37(1):35-40.
9. Pradeep SR, Guha M. Effect of processing methods on the nutraceutical and antioxidant properties of little millet (*Panicum sumatrense*) extracts. Food Chemistry. 2010; 126:1643-1647.
10. Malleshi NG, Desikachar HSR. Milling, popping and malting characteristics of some minor millet. Journal of Food Science and Technology. 1981; 22:400-403.
11. Balasubramanian S, Vishwanath R, Sharma R. Post-harvest processing of millets: an appraisal. Agricultural Engineering Today. 2007; 31(2):18-23.
12. Varadharaju N, Ganesan S. Effect of parboiling (thermal treatment) on de-hulling and cooking qualities of little millet (*Panicum sumatrense*) and foxtail millet (*Setaria italica*). 17th International Conference on Food & Nutrition. Las Vegas, USA, 2017, 22-24.
13. Mannuramath M, Yenagi N. Optimization of hydrothermal treatment for little millet grains (*Panicum miliare*). Journal of Food Science and Technology. 2015. ISSN 0022-1155. DOI: 10.1007/s13197-015-1798-z
14. Balasubramanian S, Viswanathan R. Influence of moisture content on physical properties of minor millets. Journal of Food Science and Technology. 2009; 47(3):279-284.
15. Rao SNR, Juliano BO. Effect of parboiling on some physicochemical properties of rice. Journal of Agricultural and Food Chemistry. 1970; 18(2):289-294.