= Russula virescens =

Russula virescens is a basidiomycete mushroom of the genus Russula , and is commonly known as the green @-@ cracking russula , the quilted green russula , or the green brittlegill . It can be recognized by its distinctive pale green cap that measures up to 15 cm (6 in) in diameter , the surface of which is covered with darker green angular patches . It has crowded white gills , and a firm , white stipe that is up to 8 cm (3 in) tall and 4 cm (1 @.@ 6 in) thick . Considered to be one of the best edible mushrooms of the genus Russula , it is especially popular in Spain and China . With a taste that is described variously as mild , nutty , fruity , or sweet , it is cooked by grilling , frying , sautéeing , or eaten raw . Mushrooms are rich in carbohydrates and proteins , with a low fat content .

The species was described as new to science in 1774 by Jacob Christian Schaeffer . Its distribution encompasses Asia , North Africa , Europe , and Central America . Its presence in North America has not been clarified , due to confusion with the similar species Russula parvovirescens and R. crustosa . R. virescens fruits singly or scattered on the ground in both deciduous and mixed forests , forming mycorrhizal associations with broadleaf trees such as oak , European beech , and aspen . In Asia , it associates with several species of tropical lowland rainforest trees of the family Dipterocarpaceae . R. virescens has a ribonuclease enzyme with a biochemistry unique among edible mushrooms . It also has biologically active polysaccharides , and a laccase enzyme that can break down several dyes used in the laboratory and in the textile industry .

= = Taxonomy = =

Russula virescens was first described by German polymath Jacob Christian Schaeffer in 1774 as Agaricus virescens . The species was subsequently transferred to the genus Russula by Elias Fries in 1836 . According to the nomenclatural authority MycoBank , Russula furcata var. aeruginosa (published by Christian Hendrik Persoon in 1796) and Agaricus caseosus (published by Karl Friedrich Wilhelm Wallroth in 1883) are synonyms of Russula virescens . The variety albidocitrina , defined by Claude Casimir Gillet in 1876 , is no longer considered to have independent taxonomic significance . According to Rolf Singer 's 1986 classification of Russula , R. virescens is the type species of subsection Virescentinae in section Rigidae , a grouping of mushrooms characterized by a cap surface that breaks into patches of bran @-@ like (furfuraceous) particles . In a molecular phylogenetic analysis of European Russula , R. virescens formed a clade with R. mustelina ; these two species were sister to a clade containing R. amoenicolor and R. violeipes .

The specific epithet virescens is Latin for " becoming green " . The characteristic pattern of the cap surface has earned the species common names such as the green @-@ cracking russula , the quilted green russula , and the green brittlegill . In the mid @-@ Atlantic United States , it is also known locally as the moldy russula .

= = Description = =

Described by mushroom enthusiast Antonio Carluccio as " not exactly nice to look at " , the cap is at first dome or barrel @-@ shaped , becoming convex and flattened with age with a diameter of up to 15 cm (6 in) . The cap center is often depressed . The cuticle of the cap is green , most profoundly in the center , with patches of the same color dispersed radially around the center in an areolate pattern . The color of the cuticle is often of variable shade , ranging from gray to verdigris to grass @-@ green . The extent of the patching of the cuticle is also variable , giving specimens with limited patches a resemblance to other green @-@ capped species of Russula , such as R. aeruginea . The green patches of the cap lie on a white to pale green background . The cap , while frequently round , may also exhibit irregular lobes and cracks . The cap cuticle is thin , and can be readily peeled off the surface to a distance of about halfway towards the cap center . The gills are white to cream colored , and fairly crowded together ; they are mostly free from attachment to the stipe . Gills are interconnected at their bases by veins . The stipe is cylindrical , white , and of variable height ,

up to 8 cm (3 in) tall and 4 cm (1 @.@ 6 in) wide ; it is roughly the same thickness at both the top and the base . The top portion of the stipe may be farinose ? covered with a white , mealy powder . It may turn slightly brown with age , or when it is injured or bruised from handling . Like other mushrooms in the Russulales , the flesh is brittle , owing to the sphaerocyst cytoarchitecture ? cylindrical cells that contrast with the typical fibrous , filamentous hyphae present in other orders of the basidiomycota .

The spores of R. virescens are elliptical or ellipsoid with warts , translucent (hyaline) , and produce a white , pale or pale yellow spore print ; the spore dimensions are 6 ? 9 by 5 ? 7 µm . A partial reticulum (net @-@ like pattern of ridges) interconnects the warts . The spore @-@ bearing cells , the basidia , are club @-@ shaped and have dimensions of 24 ? 33 by 6 ? 7 @.@ 5 µm ; they are colorless , and each hold from two to four spores . The pleurocystidia (cystidia on the gill face) are 40 ? 85 by 6 ? 8 µm and end abruptly in a sharp point .

= = = Similar species = = =

Russula parvovirescens , found in the eastern United States , can be distinguished from R. virescens by its smaller stature , with caps measuring 4 ? 8 cm (1 @.@ 6 ? 3 @.@ 1 in) wide and stipe up to 6 cm (2 @.@ 4 in) long by 2 cm (0 @.@ 8 in) thick . Compared to R. virescens , it tends to be more bluish @-@ green , the patches on its cap are larger , and it has a lined cap margin . Microscopically , the terminal cells in the cap cuticle of R. parvovirescens are more swollen than those of R. virescens , which has tapered and elongated terminal cells . Another green @-@ capped Russula is R. aeruginea , but this species may be distinguished from R. virescens by its smaller size and smooth cap . Other green russulas with a smooth cap include R. heterophylla and R. cyanoxantha var. peltereaui . Russula crustosa , like R. virescens , also has an areolate cap , but the cap becomes sticky (viscid) when moist , and its color is more variable , as it may be reddish , yellowish , or brown . Also , the spore print of R. crustosa is a darker yellow than R. virescens . R. redolens has a cap that is " drab @-@ green to blue @-@ green " , but unlike R. virescens , is smooth . R. redolens has an unpleasant taste and smells of parsley .

= = Edibility = =

Russula virescens is an edible mushroom considered to be one of the best of the genus Russula , and is popular in Europe , particularly in Spain . In an 1875 work on the uses of fungi , English mycologist Mordecai Cubitt Cooke remarked about the mushroom that " the peasants about Milan are in the habit of putting [it] over wood embers to toast , and eating [it] afterwards with a little salt . " The mushroom is often sold as a dried product in Asia , and in China , it can be found in roadside markets . Its smell is not distinctive , but its taste has been described as mild , nutty , fruity , or even sweet . Old specimens may smell of herrings . Drying the mushrooms enhances the nutty flavor . Mushrooms can be sautéed (the green color disappears with cooking) , and young specimens that are prepared this way have a potato taste that pairs well with shallots . They are also fried or grilled , or used raw in salads . Young specimens are pale and can be hard to identify , but the characteristic pattern of older fruit bodies makes them hard to confuse with other species . When collecting R. virescens for consumption , caution is of vital importance to avoid confusion with the dangerously poisonous Amanita phalloides (known as the death cap) , a mushroom that can be most easily identified by its volva and ring .

A lady amateur mycophagist of the writer 's acquaintance , ... who is especially fond of the green Russula , is never at a loss for this especially prized tidbit as a reward for her daily stroll among the trees . A visitor may often see upon her buffet a small glass dish filled with the mushrooms , nicely scraped and cut in pieces ? an ever @-@ present relish between meals . For even in their natural state , as she discriminatingly says , they are " as sweet as chestnuts " . This is especially the case with the " buttons " or younger specimens .

The nutritional components of R. virescens mushrooms have been characterized . Fresh mushrooms contain about 92 @.@ 5 % moisture . A 100 @-@ gram (3 @.@ 5 oz) sample of dried

mushroom (100 g dw) has 365 kcal (1527 kilojoules) . Carbohydrates make up the bulk of the fruit bodies , comprising 62 % of the dry weight ; 11 @.@ 1 % of the carbohydrates are sugars , the large majority of which (10 @.@ 9 %) is mannitol . The total lipid , or crude fat , content makes up 1 @.@ 85 % of the dry matter of the mushroom . The proportion of fatty acids (expressed as a percentage of total fatty acids) are 28 @.@ 78 % saturated , 41 @.@ 51 % monounsaturated , and 29 @.@ 71 % polyunsaturated . The most prevalent fatty acids include : palmitic acid , 17 @.@ 3 % of total fatty acids ; stearic acid , 7 @.@ 16 % ; oleic acid , 40 @.@ 27 % ; and linoleic acid , 29 @.@ 18 % . Several bioactive compounds are present in the mushroom . One hundred grams (dry weight) contains 49 @.@ 3 micrograms (µg) of tocopherols (20 @.@ 0 µg alpha , 21 @.@ 3 µg beta , and 8 @.@ 0 µg gamma) and 0 @.@ 19 milligrams (mg) of the carotenoid pigment lycopene . There are 4 @.@ 46 g of organic acids per 100 g of dry mushrooms , including oxalic acid (0 @.@ 78 g) , malic acid (2 @.@ 71 g) , citric acid (0 @.@ 55 g) , and fumaric acid (0 @.@ 23 g) . Mushrooms have 22 @.@ 6 mg / 100 g dw of the phenolic compound 4 @-@ hydroxybenzoic acid , and 15 @.@ 8 mg / 100 g dw of cinnamic acid .

= = Habitat and distribution = =

Russula virescens can be found fruiting on soil in both deciduous forests and mixed forests , forming ectomycorrhizal symbiotic relationships with a variety of trees , including oaks (Quercus) , European beech (Fagus sylvatica) , and aspen (Populus tremula) . Preliminary investigations suggest that the fungus also associates with at least ten species of Dipterocarpaceae , an important tree family prevalent in the tropical lowland forests of Southeast Asia . Fruit bodies may appear singly or in groups , reappear in the same spots year after year , and are not common . In Europe , fruiting occurs mainly during the months of summer to early autumn . A Mexican study of the seasonal occurrence of several common mushroom species in subtropical forests in Xalapa showed that the fruiting period of R. virescens occurred in April , before the onset of the rainy season .

The distribution of R. virescens in North America is subject to debate , where a number of similar species such as R. parvovirescens and R. crustosa are also recognized . One author even suggests that R. virescens " is strictly a European species " , citing Buyck and collaborators (2006) , who say " the virescens @-@ crustosa group is much more complex than suspected and embraces at least a dozen taxa in the eastern US " . As in Europe , Russula virescens has a widespread distribution in Asia , having been recorded from India , Malaysia , Korea , the Philippines , Nepal , China , Thailand , and Vietnam . It is also found in North Africa and Central America .

= = Chemistry = =

Russula virescens has a limited capacity to bioaccumulate the micronutrients iron , copper , and zinc from the soil . The concentration of these trace metals is slightly higher in the caps than the stipes . A 300 @-@ gram (11 oz) meal of fresh mushroom caps would supply 16 % of the recommended daily allowance (RDA) of copper for an adult male or female (ages 19 ? 50) ; 16 % or 7 @.@ 3 % of the RDA of iron for an adult male or female , respectively ; and 16 ? 22 % of the adult RDA of zinc . The mushroom is a poor bioaccumulator of the toxic heavy metals arsenic , cadmium , lead , mercury , and nickel .

Biologically active mushroom polysaccharides have been a frequent research topic in recent decades due to their possible stimulatory effect on innate and cell @-@ mediated immune responses , antitumor activities , and other activities . Immunostimulatory activity , antioxidant activity , cholesterol @-@ lowering , and blood sugar @-@ lowering effects have been detected in extracts of R. virescens fruit bodies , which are attributed to polysaccharides . A water @-@ insoluble beta @-@ glucan , RVS3 @-@ II , has been isolated from the fruit bodies . Sulfated derivatives of this compound have antitumor activities against sarcoma tumor cell lines . RVP , a water @-@ soluble polysaccharide present in the mushroom , is made largely of galactomannan subunits and has antioxidant activity .

Ribonucleases (or RNases) are enzymes that catalyze the hydrolysis of ribonucleic acid (RNA) ,

and collectively they play a critical role in many biological processes . A RNase from R. virescens was shown to be biochemically unique amongst seven edible mushroom species in several ways : it has a co @-@ specificity towards cleaving RNA at poly A and poly C , compared to the monospecific RNases of the others ; it can be adsorbed on chromatography columns containing DEAE ? cellulose as the adsorbent ; it has a pH optimum of 4 @.@ 5 , lower than all other species ; and , it has a " distinctly different " N @-@ terminal amino acid sequence . The mushroom contains a unique laccase enzyme that can break down several dyes used in the laboratory and in the textile industry , such as bromothymol blue , eriochrome black T , malachite green , and reactive brilliant blue . Laccases are being used increasingly in the textile industry as environmental biocatalysts for the treatment of dye wastewater .