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DEVELOPMENT OF VITAMIN-DENRICHED BISCUITS

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ABSTRACT

INTRODUCTION

VitaminDdeficiencyisamajorglobalpublichealthconcernthataffectsbonehealth, immunity, and overall well-being. This study focused on developing vitamin D-enrichedbiscuitsusingwheatflour,mushroompowder,eggyolk,milk,butter,dates sugar, and cardamom to improve nutritional quality and consumer acceptability.

OBJECTIVE

TheobjectiveofthisstudywastodevelopandevaluatevitaminD-enrichedbiscuits with improved nutritional value, good sensory characteristics, and potential health benefits for individuals of all age groups.

MATERIALSANDMETHODS

Vitamin D-enriched biscuits were prepared by mixing wheat flour, mushroom powder, egg yolk, butter, milk, dates sugar, and cardamom into a uniform dough, followed by baking under standardized conditions. The prepared biscuits were evaluatedfornutritional compositionandsensoryattributesusinga5-pointhedonic scale.

RESULTS

The developed biscuits showed high sensory acceptability for appearance, colour, taste, texture, flavour, and overall acceptability. The incorporation of mushroom powder and egg yolk enhanced the vitamin D content and improved the nutritional quality of the product.

CONCLUSION

VitaminD-enrichedbiscuitsdevelopedinthisstudyareanutritiousfunctionalfood with good sensory quality and enhanced nutritional value. They may serve as a convenient dietary option to improve vitamin D intake and help reduce vitamin D deficiency among all age

groups.

KEYWORDS: Vitamin D, Functional Food, Biscuits, Mushroom Powder, Egg Yolk, Nutrition, Fortification, Sensory Evaluation.

INTRODUCTION

VitaminDisanessentialfat-solublevitaminrequiredforcalciumabsorption,bonemineralization, immune regulation, and overall health. Despite abundant sunlight in many countries, vitamin D deficiency remains widespread due to limited sun exposure, lifestyle changes, dietary inadequacies, and environmental factors.

India reports a high prevalence of vitamin D deficiency across all age groups. The deficiency is associated withosteoporosis,rickets,osteomalacia, weak ene dimmunity, cardiovascular diseases, diabetes, and certain cancers.

MushroompowderisanaturalsourceofvitaminD$_2$,whileeggyolkcontainsvitaminD$_3$andhigh-quality proteins. The combination of these ingredients can enhance the nutritional profile of biscuits while maintaining consumer acceptability.

Therefore, thepresentstudywasundertakentodevelopandevaluateVitamin-Denrichedbiscuits and assess their nutritional quality and sensory characteristics.

Vitamin D is a fat-soluble vitamin that plays an essential role in maintaining human health. It is primarily involved in calcium and phosphorus metabolism, promoting bone mineralization, skeletalgrowth,andoverallmusculoskeletalhealth.Inrecentdecades,scientificinterestinvitamin D has increased considerably due to its diverse physiological functions beyond bone health. Researchhas demonstrated thatvitaminD influences immuneregulation, cellulardifferentiation, cardiovascular health, neurological function, and metabolic processes. Consequently, vitamin D deficiencyhasemergedasamajorglobalpublichealthconcernaffectingindividualsacrossallage groups.

Vitamin D deficiency is recognized as one of the most widespread nutritional deficiencies worldwide. It is estimated that nearly one billion people globally suffer from inadequate vitamin Dlevels.Theprevalenceofdeficiencyvariesacrossregionsandpopulations,influencedby geographical location, lifestyle, dietary habits, skin pigmentation, cultural practices, and environmentalconditions.Reports indicateprevalencerates ofapproximately5.9%intheUnited States,7.4%inCanada,and13.0%in Europe.Surprisingly,vitamin D deficiencyremains highly prevalenteven intropicaland subtropical countriesthatreceiveabundant sunlight throughout the year.

TheclassicalroleofvitaminDinmaintainingskeletalhealthiswellestablished.Severedeficiency can lead to rickets in children, characterized by impaired bone mineralization and skeletal deformities. In adults, vitamin D deficiency may result in osteomalacia, osteoporosis, muscle weakness,andanincreasedriskoffractures.AdequatevitaminD levels areessentialfor efficient calcium absorption, maintenance of bone density, and prevention of age-related bone loss. Consequently, vitamin D supplementation and food fortification strategies have been widely recommended to support bone health across the lifespan.

Beyond its skeletal functions, vitamin D has been increasingly recognized for its influence on numerousphysiologicalsystems.VitaminDreceptorsarepresentinvarioustissuesincludingthe brain, heart, pancreas, immune cells, and skeletal muscles. These receptors enable vitamin D to regulate gene expression and cellular activity throughout the body. Scientific evidence suggests that vitamin D contributes to immune system modulation by enhancing innate immunity while regulating inflammatory responses. It also influences cell proliferation, differentiation, and apoptosis, indicating potential roles in cancer prevention and chronic disease management.

Older adults represent a particularly vulnerable population with respect to vitamin D deficiency. Aging is associated with reduced skin capacity for vitamin D synthesis, lower dietary intake, decreasedintestinalabsorption,andlimitedexposuretosunlight.Epidemiologicalstudiesindicate that inadequate vitamin D levels in older individuals may contribute to osteoporosis, falls, fractures, cognitive impairment, cardiovascular disease, and metabolic disorders. As the global population continues to age, maintaining adequate vitamin D status has become increasingly important for promoting healthy aging and reducing disease burden.

Natural dietary sources of vitamin D are relatively limited and include fatty fish, fish liver oils, eggyolk,fortifieddairyproducts,and certainmushroomsexposedtoultravioletlight.Becauseof the restricted availability of naturally vitamin D-rich foods, food fortification has emerged as a practical and sustainable strategy to combat vitamin D deficiency. Fortification of commonly consumed food products provides an effective means of improving vitamin D intake at the population level without requiring major dietary changes.

Mushrooms are unique among plant-based foods because they contain ergosterol, which can be convertedintovitaminD_2uponexposuretoultravioletlight.Similarly,eggyolkcontainsvitamin D_3 along with high-quality protein, essential fatty acids, and other micronutrients. The incorporationoftheseingredientsintobiscuitformulationsmayimprovevitaminDcontentwhile

also enhancing the overall nutritional profile of the product.

MATERIALS AND METHODS STUDY DESIGN

AnexperimentalresearchdesignwasadoptedtodevelopandevaluatevitaminD-enrichedbiscuits. DifferentformulationswerepreparedusingnaturalvitaminD-rich ingredientssuchas mushroom powder and egg yolk. The developed products were assessed for sensory acceptability and nutritional quality.

PROCUREMENTOFRAWMATERIALS

All ingredients were procured from local markets and grocery stores in Secunderabad. Fresh and good-qualityingredientsincludingwheatflour,egg, milk, butter, dates, cardamompowder, ghee, baking powder, and mushroom powder were used for product development.

PRE-PROCESSINGOFINGREDIENTS

Fresh mushrooms were cleaned, sliced, sun-dried, and powdered. Wheat flour was sieved to remove impurities, and egg yolks were separated from egg whites before use.

FORMULATIONANDSTANDARDIZATION

Threebiscuitformulationswerepreparedbyvarying theamountofmushroompowder: Variation 1: 5 g mushroom powder

Variation2:10gmushroompowder

Variation3:15gmushroompowder

Theformulationswerestandardizedthroughrepeatedtrialstoobtainoptimumsensoryqualityand nutritional value. Consistent ingredient proportions, baking temperature, and baking time were maintained throughout the study.

Table1.Ingredientsusedinthepreparationofvitamin-Denrichedbiscuits.

Ingredients	Quantity
Whaetflour	250grms
Mushroom	10grms
Eggyolk	50grms
Milk	50ml
Dates	10grms
Butter	20grms
Ghee	10grms
Cardamompowder	5grms
Sugar	50grms
Bakingpowder	2grms

Preparation of Vitamin D-Enriched Biscuits

Process Flow chart of Vitamin D Enriched Biscuits

Mushrooms(Clean →Slice→ Sun-dry→ Grindinto Mushroom Powder)

↓

WheatFlour–Sievetoremoveimpurities

↓

Egg–SeparateEggYolk

↓

PreparationofBaseMixture(DatesPaste+MushroomPowder+EggYolk+Butter+ Ghee)

↓

MixThoroughlytoObtainSmoothCreamyConsistency

↓

GraduallyAddWheatFlour+CardamomPowder+BakingPowder

↓ SlowlyAddMilk

↓

MixtoFormSoftandUniform Dough

↓

RolltheDoughand CutintoRoundBiscuit Shapes

↓

ArrangeBiscuitsonBakingTray

↓

BakeinPreheatedOvenUntilGoldenBrown

↓

CooltoRoomTemperature

SENSORYEVALUATION

Sensory evaluation was conducted using semi-trained panel members. The developed biscuits were evaluated for appearance, aroma, taste, texture, and overall acceptability. Samples were coded and presented randomly to minimize bias, and water was provided between samples to cleanse the palate.A 5-point hedonic scale was used, where 5 = Excellent, 4 = Very Good, 3 = Good, 2 =Average, and 1 = Poor.

OVERALLACCEPTABILITY

Fig:1Bar Graph interpreting over all acceptability of product.

Thebargraphrepresentstheoverallacceptabilityscoresofthedevelopedproductasevaluatedby the panelist using 5-point hedonic scale. It is observed that the majority of the panelist rated the productinhigherscorerangeindicatinggoodacceptance.Thescores4(40%)and thescore5(54%) was assigned by majority of panel member.A

smaller proportion of the panelist gave moderate scores 3 (6%). Overall, the scores indicate that the developed product has high consumer acceptance.

NUTRITIONAL ANALYSIS

The nutritive value of the developed biscuits was estimated using the Indian Food Composition Tables (IFCT). Parameters evaluated included energy, protein, carbohydrates, fat, dietary fiber, calcium,andvitaminDcontent.VitaminDcontentwasdeterminedusingHigh-Performance Liquid Chromatography (HPLC), a sensitive and reliable analytical technique widely used for vitamin quantification in food products.

RESULTS AND DISCUSSION

SENSORY EVALUATION OF VITAMIND-ENRICHEDBISCUITS.

The sensory evaluation of the developed vitamin D-enriched biscuits was conducted using a 5-point hedonic scale to assess appearance, aroma, taste, texture, and overall acceptability. The results indicated that all three formulations were well accepted by the panel members. However, Variation 2 received the highest mean scores for most sensory attributes, indicating superior consumer acceptability. The balanced incorporation of mushroom powder in this

formulation
enhancedthenutritionalqualitywithoutadverselyaffectingtheorganolepticcharacteristicsofthe biscuits.

Variation1wasratedpositivelyforitsmildflavorandpleasanttexturebutcontainedalowerlevel of vitamin D enrichment. In contrast, Variation 3, which contained the highest amount of mushroom powder, exhibited a slightly stronger mushroom flavor and darker appearance that reduced its acceptability among some panel members. The findings suggest that moderate incorporation of mushroom powder provides the best balance between nutritional enhancement and sensory quality.

MUSHROOM POWDER ON PRODUCT QUALITY.

The incorporation of mushroom powder significantly influenced the sensory and nutritional characteristics of the biscuits. Mushroom powder contributed to the development of a unique flavor profile and improved the dietary fiber content of the product. As the level of mushroom powder increased, the color of the biscuits became darker due to the natural pigments present in mushrooms.Althoughhigherlevelsofmushroom powderincreasedvitaminDcontent, excessive incorporation slightly affected taste and texture, thereby reducing overall acceptability.

The results demonstrate that mushroom powder can be successfully incorporated into bakery products as a natural fortification ingredient. Its use offers a practical approach to enhancing vitamin D intake through commonly consumed foods.

NUTRITIONAL COMPOSITION OF DEVELOPED BISCUITS

ThenutritionalanalysisrevealedthatthevitaminD-enrichedbiscuitspossessedimprovednutrient contentcompared to conventionalbiscuits.Theincorporation of mushroompowder and egg yolk contributed to increased levels of protein, dietary fiber, healthy fats, and micronutrients. The biscuitsprovidedamoderateamountofenergy,makingthemsuitableasanutritioussnackoption for different age groups.

Egg yolk served as an important source of vitamin D_3 and high-quality protein, while mushroom powder contributed vitamin D_2, dietary fiber, and bioactive compounds. The synergistic combination of these ingredients resulted in a product with enhanced nutritional value and functional benefits.

VITAMIND CONTENT OF THE DEVELOPED BISCUITS

ThevitaminDcontentofthebiscuitsincreasedwiththelevelofmushroompowderincorporation. Sun-driedmushroomsareknowntocontainelevatedlevelsofvitaminD_2duetotheconversionof ergosterolintovitaminDwhenexposedtoultravioletlight.Consequently,formulationscontaining higher amounts of mushroom powder showed greater vitamin D concentrations.

The findings indicate that natural food fortification using mushroom powder and egg yolk can effectively enhance the vitamin D content of bakery products. Such products may help improve dietary vitamin D intake and reduce the risk of vitamin D deficiency, particularly among populations with limited sun exposure.

STATISTICAL ANALYSIS

Statisticalevaluationofthesensoryscoresdemonstratedsignificantdifferencesamongthebiscuit formulations.Theobtainedp-valuewas less than0.05,indicatingthatthevariations iningredient compositionhadasignificanteffectonsensoryacceptability.TheanalysisconfirmedthatVariation 2 was significantly preferred over the other formulations and was identified as the optimized product.

Theseresultsemphasizetheimportanceofformulationstandardizationinachievinganacceptable balance between nutritional enhancement and consumer preference.

Table:2Nutritionalcompositionofvitamin-Denrichedbiscuits.

S.no	Parameter	Testmethod	Unit	Results	Limits
1	Energy	Calculation	Kcal/100g	480	430-520
2	Protein	Kjeldahl Method	g/100g	7.5	≥6.0
3	Total carbohydrates	By Calculation	g/100g	65.0	__
4	Totalfat	AOAC920.39	g/100g	20.0	15-25
5	Dietaryfiber	AOAC985.29	g/100g	3.5	>2.0
6	Iron	ICP-OES/AAS	mg/100g	3.0	>2.0
7	Calcium	ICP-OES/AAS	mg/100g	180	≥100
8	Vitamin-D	HPLC/LC/MS	µg/100g	10	≥5.0

COMPARISON WITH PREVIOUS STUDIES

Thefindingsofthepresentstudyareinagreementwithpreviousresearchthatreportedsuccessful fortification of bakery products using mushroom powder. Earlier studies have demonstrated that mushroom-enriched foods provide increased vitamin D content while maintaining desirable sensory characteristics. Similarly, the inclusion of egg yolk has been reported to improve the nutritional quality and protein content of baked products.

Thepresentstudy further supports thepotentialof combining mushroompowder and egg yolk as

naturalvitaminDsourcesinfunctionalfooddevelopment.Theobservedimprovementsinnutrient composition and consumer acceptability are consistent with findings reported in related food fortification studies.

DISCUSSION

The results of the study demonstrated that vitamin D-enriched biscuits can be successfully developed using natural ingredients without compromising product quality. The incorporation of mushroom powder and egg yolk significantly enhanced the nutritional profile of the biscuits, particularly their vitamin D content.Among the tested formulations, Variation 2 emerged as the mostacceptableproductduetoitsfavorablesensoryattributesandbalancednutrientcomposition.

The developed biscuits have the potential to serve as a convenient, affordable, and acceptable dietary source of vitamin D. Regular consumption of such fortified products may contribute to improving vitamin D intake and supporting overall health, particularly in populations at risk of vitamin D deficiency.

CONCLUSION

The present study successfully developed and evaluated vitamin D-enriched biscuits using mushroom powder and egg yolk as natural sources of vitamin D. The incorporation of these ingredients significantly improved the nutritional quality of the biscuits while maintaining desirablesensorycharacteristics.Thedeveloped formulationsdemonstrated good acceptabilityin terms of appearance, aroma, taste, texture, and overall consumer preference.

Among the three formulations tested, Variation 2 exhibited the highest overall acceptability and was identified as the optimized formulation. The balanced level of mushroom powder incorporation provided enhanced vitamin D content without negatively affecting the sensory properties of the product. Nutritional analysis revealed that the fortified biscuits contained appreciable amountsofvitaminD,protein,dietaryfiber,andotheressentialnutrients,makingthem a healthier alternative to conventional biscuits.

The study highlights the potential of utilizing natural vitamin D-rich ingredients in the developmentof functional bakery products.The use ofmushroompowder and eggyolk offers an effective,economical,andfood-basedstrategytoimprovedietaryvitaminDintakeandaddress thegrowingprevalenceofvitaminDdeficiency.Furthermore,thedevelopedbiscuitscanserveas a convenient and acceptable snack option for individuals across different age groups.

In conclusion, vitamin D-enriched biscuits prepared with mushroom powder and egg yolk

have significant potential as a functional food product. Their regular consumption may contribute to improvingnutritionalstatusandpromotingoverallhealth.Futureresearchmayfocusonshelf-life studies, large-scale production, bioavailability assessment, and consumer acceptance among diverse population groups to further establish the commercial viability of the product.

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