Indian Journal of Experimental Biology
Vol. 64, March 2026, pp.267-283
DOI:10.56042/ijeb.v64i03.20491

Probiotic properties and safety assessment of *Enterococcus durans* DMGUD5 and its suitability as a dairy starter culture to manufacture fermented dairy product

Deepak Meghwal[1], Kamalesh Kumar Meena[1]*, Lokesh Gupta[2], Manvik Joshi[3] & Sunil Meena[4]

[1]Department of Dairy and Food Microbiology, [2]College of Dairy and Food Technology, [3]Department of Dairy and Food Chemistry, Maharana Pratap University of Agriculture and Technology, Udaipur, 313001, India

[4]Department of Dairy Science and Food Technology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, 221005, India

Received 10 June 2025; revised 16 October 2025

Suppl. Table 1 — Biochemical test for exopolysaccharide-producing (EPS) lactic acid bacteria (LAB)

Characteristics	Isolate					
	DMGUD5	DMGUD10	DMGUD17	DMGUD21	DMGUD36	DMGUD41
Gram's staining	Gram +ve	Gram +ve	Gram +ve	Gram +ve	Gram +ve	Gram +ve
Spore staining	Non-spore former	Non-spore former	Non-spore former	Non-spore former	Non-spore former	Non-spore former
Catalase test	-*	-	-	-	-	-
Oxidase test	-	-	-	-	-	-
Urease test	-	-	-	-	-	-
Nitrate reduction test	-	-	-	-	-	-
Citrateutilization	-	-	-	-	-	-
Sugartype	Carbohydrate fermentation test					
Sucrose	+	+	+	-	+	-
Fructose	+	+	+	+	+	+
Maltose	+	+	-	+	+	-
Lactose	+	+	+	+	+	+
Trehalose	+	+	+	+	+	+
Mannitol	+	+	-	-	-	-
Cellobiose	-	+	-	+	-	-
Galactose	+	-	-	-	-	-
Mannose	+	+	+	+	-	+
Salicin	+	-	+	-	-	-
Xylose	+	-	-	-	+	-

*+ = Positive (Indicates color change) and- = Negative (No color change)

Suppl. Table 2 — Growth at different temperature

ISOLATE	15 °C	37 °C	45 °C
DMGUD 5	++*	++++	+++
DMGUD 10	++	++++	+++
DMGUD 17	++	+++	+++
DMGUD 21	+	++	++
DMGUD 36	++	++++	+++
DMGUD 41	+	+++	++

*- : No growth, +: Very less growth,++ :less growth, +++ :moderate growth, ++++ :heavy growth

Table 3 — Growth in different salt concentration

Isolate	Salt concentration	
	4%	6.50%
DMGUD 5	++++*	+++
DMGUD 10	++++	+++
DMGUD 17	+++	++
DMGUD 21	++	++
DMGUD 36	++	+
DMGUD 41	+++	++

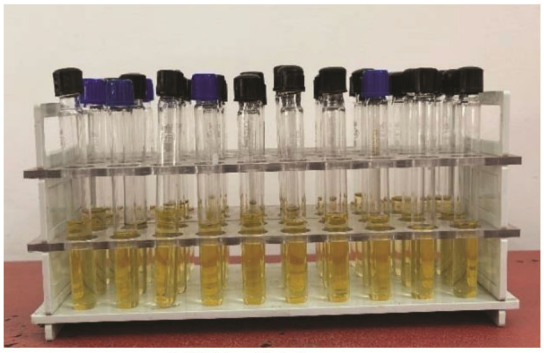
*- = No growth, + = Very less growth,++ = less growth, +++ =moderate growth, ++++ = heavy growth

Suppl. Table 4 — Growth at different pH

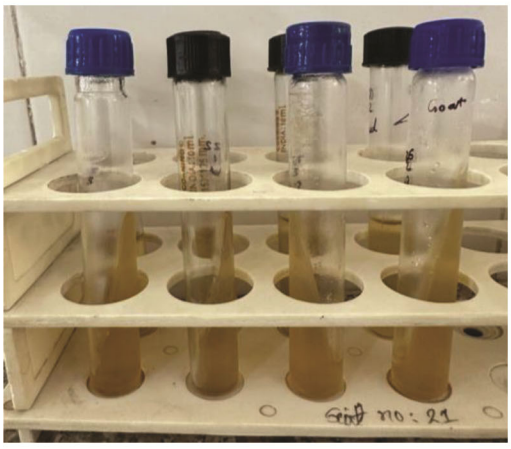
Isolate	pH		
	3.5	6.5	8.5
DMGUD 5	++*	++++	+++
DMGUD 10	++	++++	+++
DMGUD 17	++	+++	++
DMGUD 21	+	+++	++
DMGUD 36	++	+++	++
DMGUD 41	+	++	+

*- = No growth, + = Very less growth,++ = less growth, +++ = moderate growth, ++++ = heavy growth

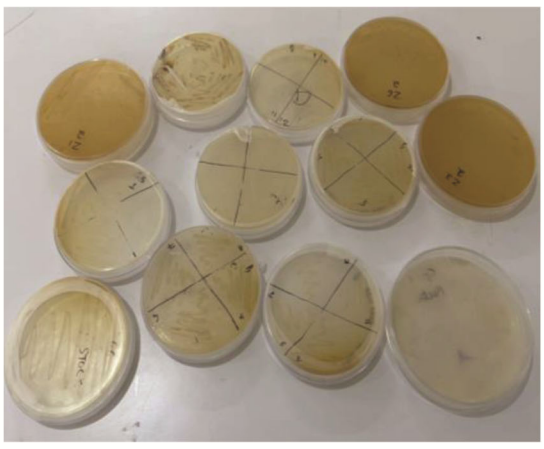
Dilution tubes



MRS broth tubes

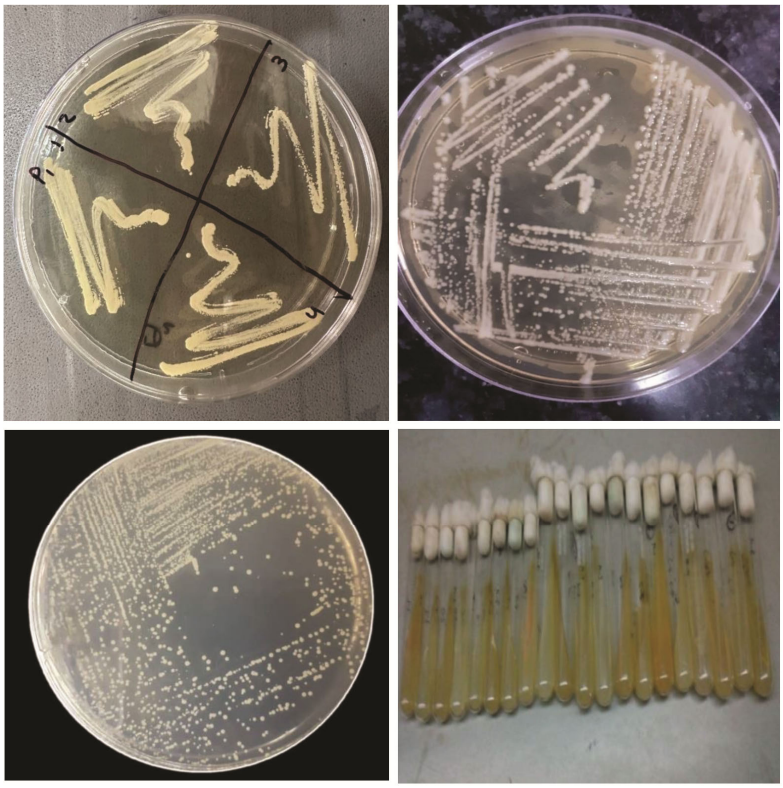


MRS agar slant tubes

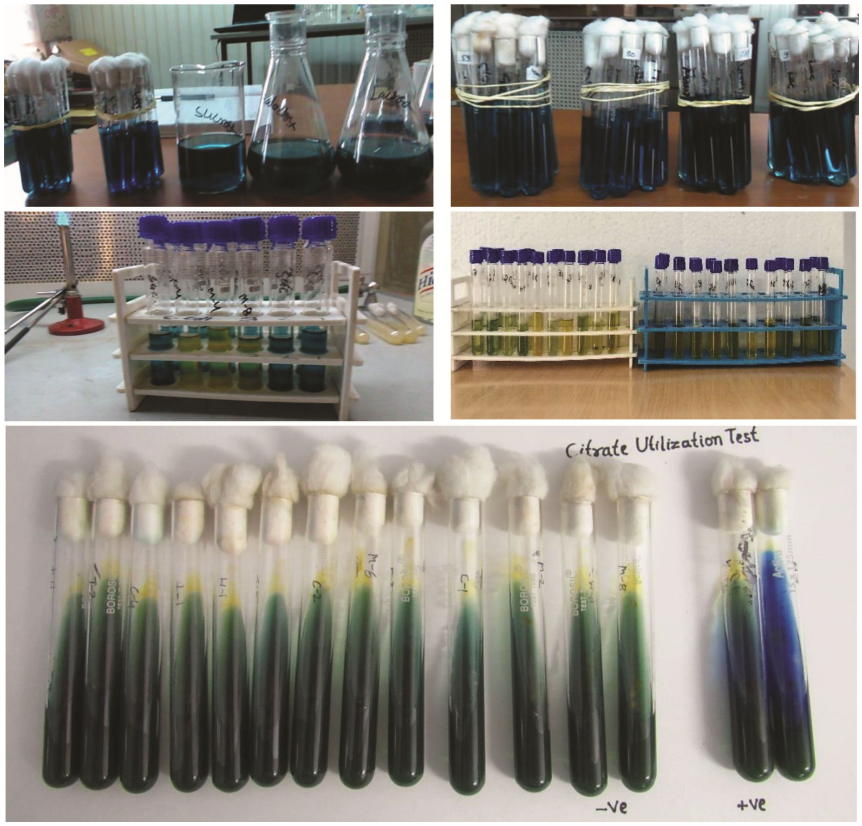


MRS agar plates

Suppl. Figure 1 — Preparation for isolation of lactic acid bacteria

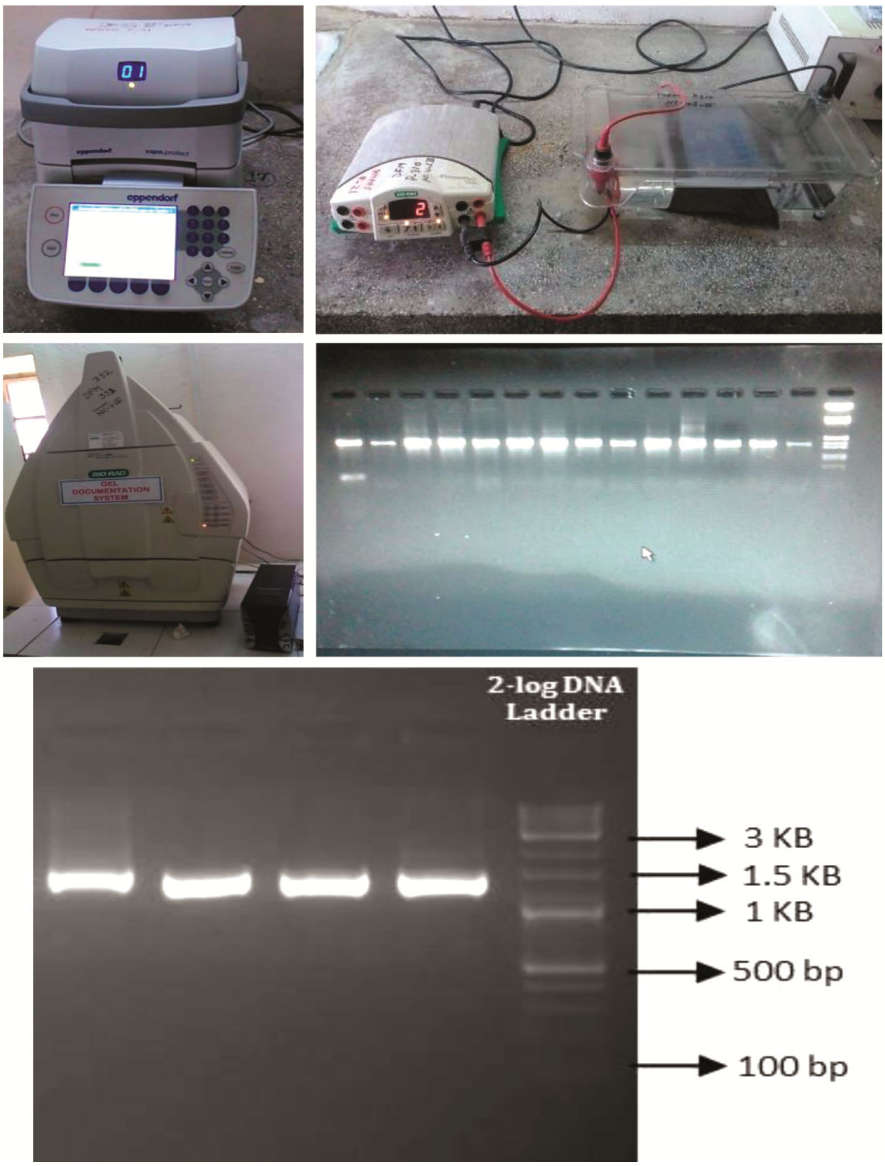


Suppl. Figure 2 — Purification and preservation of LAB isolates on agar plates

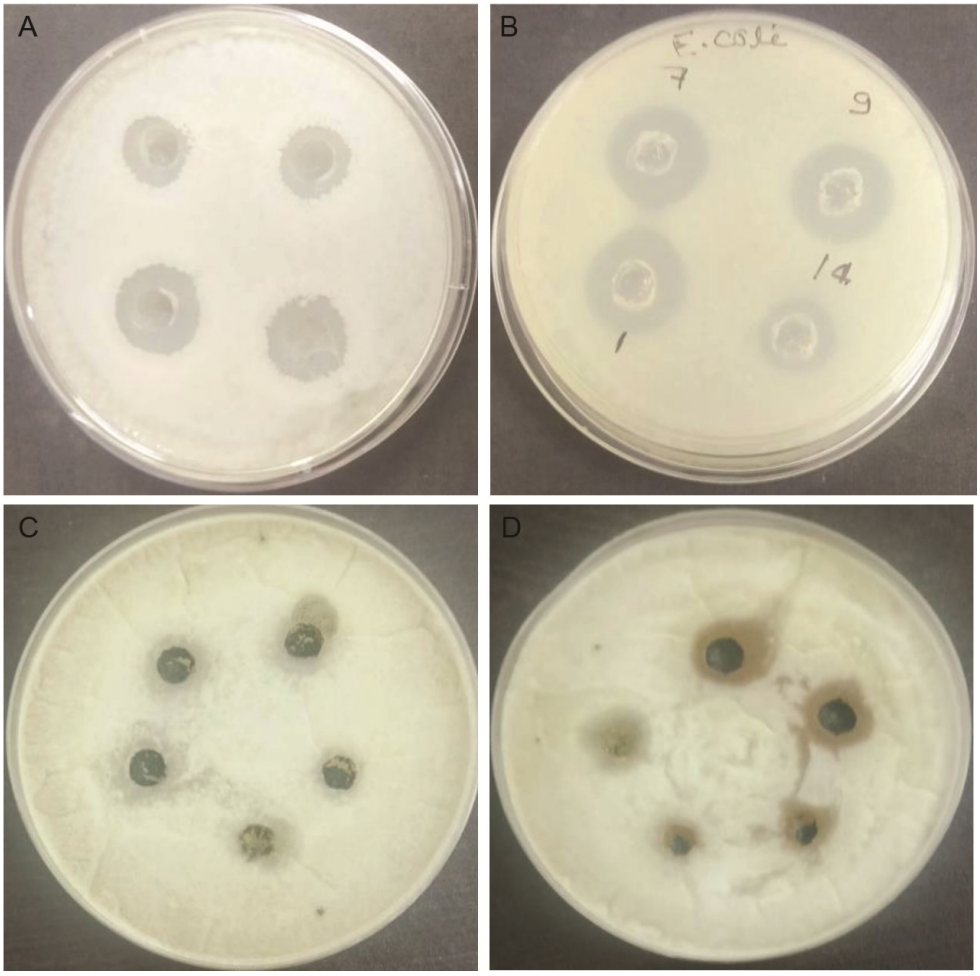


Suppl. Figure 3: Biochemical characterization of LAB isolates

Suppl. Figure 4 — Antibiotic susceptibility profile of EPS-producing LAB against various tested antibiotics



Suppl. Figure 5 — Molecular identification of EPS-producing LAB using 16s rRNA sequencing



Suppl. Figure 6 — Antimicrobial (A, B) and Antifungal (C, D) activity of EPS-producing LAB strains

Sequences of isolates

1. DMGUD5

GCCCATCACAAGGGGATAACACTTGGAAACAGGTGCTAATACCGTATAAC
AATCGAAACCGCATGGTTTTGATTTGAAAGGCGCTTTCGGGTGTCGCTGAT
GGATGGACCCGCGGTGCATTAGCTAGTTGGTGAGGTAACGGCTCACCAAG
GCGACGATGCATAGCCGACCTGAGAGGGTGATCGGCCACATTGGGACTGA
GACACGGCCCAAACTCCTACGGGAGGCAGCAGTAGGGAATCTTCGGCAAT
GGACGAAAGTCTGACCGAGCAACGCCGCGTGAGTGAAGAAGGTTTTCGG
ATCGTAAAACTCTGTTGTTAGAGAAGAACAAGGATGAGAGTAACTGTTCA
TCCCTTGACGGTATCTAACCAGAAAGCCACGGCTAACTACGTGCCAGCAG
CCGCGGTAATACGTAGGTGGCAAGCGTTGTCCGGATTTATTGGGCGTAAA
GCGAGCGCAGGCGGTTTCTTAAGTCTGATGTGAAAGCCCCCGGCTCAACC
GGGGAGGGTCATTGGAAACTGGGAGACTTGAGTGCAGAAGAGGAGAGTG
GAATTCCATGTGTAGCGGTGAAATGCGTAGATATATGGAGGAACACCAGT
GGCGAAAGCGGCTCTCTGGTCTGTAACTGACGCTGAGGCTCGAAAGCGTG
GGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCGTAACGATGAGT
GCTAAGGTGTTGGAAGGGTTTCCGCCCTTCAGTGCTGCAGCTA

2. *DMGUD10*

AGTCGAAACCGCATGGTTTTGATTTGAAAGGCGCTTTCGGGTGTCGCTGAT
GGATGGACCCGCGGTGCATTAGCTAGTTGGTGAGGTAACGGCTCACCAAG
GCGACGATGCATAGCCGACCTGAGAGGGTGATCGGCCACATTGGGACTGA
GACACGGCCCAAACTCCTACGGGAGGCAGCAGTAGGGAATCTTCGGCAAT
GGACGAAAGTCTGACCGAGCAACGCCGCGTGAGTGAAGAAGGTTTTCGG
ATCGTAAAACTCTGTTGTTAGAGAAGAACAAGGATGAGAGTAACTGTTCA
TCCCTTGACGGTATCTAACCAGAAAGCCACGGCTAACTACGTGCCAGCAG
CCGCGGTAATACGTAGGTGGCAAGCGTTGTCCGGATTTATTGGGCGTAAA
GCGAGCGCAGGCGGTTTCTTAAGTCTGATGTGAA

3. *DMGUD17*

TGATGTGAAAGCCCCCGGCTCAACCGGGGAGGGTCATTGGAAACTGGGAG
ACTTGAGTGCAGAAGAGGAGAGTGGAATTTCCATGTGTAGCGGTGAAATG
CGTAGATATATGGAGGAACACCAGTGGCGAAGGCGGCTCTCTGGTCTGTA
ACTGACGCTGAGGCTCGAAAGCGTGGGGAGCAAACAGGATTAGATACCCT
GGTAGTCCACGCCGTAAACGATGAGTGCTAAGTGTTGGAGGGTTTCCGCC

GCAAGGTTGAAACTCAAAGGAATTGACGGGGGCCCGCACAAGCGGTGGA
GCATGTGGTTTAATTCGAAGCAACGCGAAGAACCTTACCAGGTCTTGACA
TCCTTTGACCACTCTAGAGATAGAGCTTCCCCTTCGGGGGCAAAGTGACA
GGTGGTGCATGGTTGTCGTCAGCTCGTGTCGTGAGATGTTGGGTTAAGTCC
CGCAACGAGCGCAACCCTTATTGTTAGTTGCCATCATTTAGTTGGGCACTC
TAGCAAGACTGCCGGTGACAAACCGGAGGAAGGTGGGGATGACGTCAAA
TCATCATGCCCCTTATGACCTGGGCTACACACGTGCTACAATGGGAAGTA CA

4. *DMGUD21*

ACTGGCAAGTTTGAGCGCTGAAAGGTTGGGTACTTGTACCGACTGGATGA
GCAGCGAACGGGTGAGTAACGCGTGGGGAATCTGCCTTTGAGCGGGGGA
CAACATTTGGAAACGAATGCTAATACCGCATAAAAACTTTAAACACAAGT
TTTAAGTTTGAAAGATGCAATTGCATCACTCAAAGATGATCCCGCGTTGTA
TTAGCTAGTTGGTGAGGTAAAGGCTCACCAAGGCGATGATACATAGCCGA
CCTGAGAGGGTGATCGGCCACATTGGGACTGAGACACGGCCCAAACTCCTAC
GAGGCAGCAGTAGGGAATCTTCGGCAATGGACGAAAGTCTGACCGAGCAAC
CGCGTGAGTGAAGAAGGTTTTCGGATCGTAAAACTCTGTTGG
AGAGAAGAACGTTGGTGAGAGTGGAAAGCTCATCAAGTGACGGTAACT
ACCCAGAAAGGGACGGCTAACTACGTGCCAGCAGCCGCGGTAATACGTA
GGTCCCGAGCGTTGTCCGGATTTATTGGGCGTAAAGCGAGCGCAGGTGGT
TTATTAAGTCTGGTGTAAAAGGCAGTGGCTCAACCATTGTATGCATTGGA
AACTGGTAGACTTGAGTGCAGGAGAGGAGAGTGGAATTCCATGTGTAGCG
GTGAAATGCGTAGATATATGGAGGAACACCGGTGGCGAAAGCGGCTCTCT
GGCCTGTAACTGACACTGAGGCTCGAAAGCGTGGGGAGCAAACAGGATT
AGATACCCTGGTAGTCCACGCCGTAAACGATGAGTGCTAGATGTAGGGAG
CTATAAGTTCTCTGTATCGCAGCTAACGCAATAAGCACTCCGCCTGGGGA
GTACGACCGCAAGGTTGAAACTCAAAGGAATTGACGGGGGCCCGCACAA
GCGGTGGAGCATGTGGTTTAATTCGAAGCAACGCGAAGAACCTTACCAGG
TCTTGACATACTCGTGCTATTCCTAGAGATAGGAAGTTCCTTCGGGACACG
GGATACAGGTGGTGCATGGTTGTCGTCAGCTCGTGTCGTGAGATGTTGGG
TTAAGTCCCGCAACGAGCGCAACCCCTATGGTTAGTTGCCATCATTAAGTT
GGGCACTCTAACG

5. *DMGUD36*

TCGGGATTTATTGGGCGTAAAGCGAGCGCAGGCGGTTTCTTAAGTCTGAT
GTGAAAGCCCCCGGCTCAACCGGGGAGGGTCATTGGAAACTGGGAGACTT

GAGTGCAGAAGAGGAGAGTGGAATTCCATGTGTAGCGGTGAAATGCGTA
GATATATGGAGGAACACCAGTGGCGAAGGCGGCTCTCTGGTCTGTAACTG
ACGCTGAGGCTCGAAAGCGTGGGGAGCAAACAGGATTAGATACCCTGGT
AGTCCACGCCGTAAACGATGAGTGCTAAGTGTTGGAGGGTTTCCGCCCTT
CAGTGCTGCAGCTAACGCATTAAGCACTCCGCCTGGGGAGTACGACCGCA
AGGTTGAAACTCAAAGGAATTGACGGGGGCCCGCACAAGCGGTGGAGCA
TGTGGTTTAATTCGAAGCAACGCGAAGAACCTTACCAGGTCTTGACATCCT
TTGACCACTCTAGAGATAGAGCTTCCCCTTCGGGGGCAAAGTGACAGGTG
GTGCATGGTTGTCGTCAGCTCGTGTCGTGAGATGTTGGGTTAAGTCCCGCA
ACGAGCGCAACCCTTATTGTTAGTTGCCATCATTCAGTTGGGCACTCTAGC
AAGACTGCCGGTGACAAACCGGAGGAAGGTGGGGATGACGTCAAATCAT
CATGCCCCTTATGACCTGGGCTACACACGTGCTACAATGGGAAGTACAAC

6. *DMGUD41*

AACCGCAAGGTTTTGATTTGAAAGGCGCTTTCGGGTGTCGCTGATGGATG
GACCCGCGGTGCATTAGCTAGTTGGTGAGGTAACGGCTCACCAAGGCGAC
GATGCATAGCCGACCTGAGAGGGTGATCGGCCACATTGGGACTGAGACAC
GGCCCAAACTCCTACGGGAGGCAGCAGTAGGGAATCTTCGGCAATGGACG
AAAGTCTGACCGAGCAACGCCGCGTGAGTGAAGAAGGTTTTCGGATCGTA
AAACTCTGTTGTTAGAGAAGAACAAGGATGAGAGTAACTGTTCATCCCTT
GACGGTATCTAACCAGAAAGCCACGGCTAACTACGTGCCAGCAGCCGCGG
TAATACGTAGGTGGCAAGCGTTGTCCGGATTTATTGGGCGTAAAGCGAGC
GCAGGCGGTTTCTTAAGTCTGATGTGAAAGCCCCCGGCTCAACCGGGGAG
GGTCATTGGAAACTGGGAGACTTGAGTGCAGAAGAGGAGAGTGGAATTC
CATGTGTAGCGGTGAAATGCGTAGATATATGGAGGAACACCAGTGGCGAA
GGCGGCTCTCTGGTCTGTAACTGACGCTGAA