

RESEARCH ARTICLE

3D-printed amino acid-restricted foods for special medical purposes to support cancer nutrition therapy

Supplementary File
Table S1. Nutrient composition of the serine/glycine-free diet nutritional powder

Nutrient	Amount per 100 g product (kJ, g, mg, or µg as applicable)	% daily value provided per 100 g product
Energy	1,978	23.55%
Protein	16.6	27.67%
Fat	22.2	7.00%
Carbohydrate	49.4	16.47%
Dietary fibre	4.32	17.28%
Sodium	794	39.70%
Vitamin B1	2.01	143.57%
Vitamin B2	1.82	130.00%
Nicotinic acid	27.09	180.60%
Vitamin B12	2.56	106.67%
Vitamin C	218.3	218.30%
Gly	ND	ND
Ala	0.011	1.06%
GABA	7.20×10^{-6}	0.00072%
Ser	ND	ND
Pro	0.0064	0.64%
Val	0.0079	0.79%
Thr	0.0076	0.76%
Ile	0.0063	0.63%
Leu	0.012	1.12%
Asn	ND	ND
Orn	0.00013	0.013%
Asp	0.015	1.50%
Hcy	ND	ND
Gln	0.30	30%
Lys	0.012	1.24%
Glu	0.00044	0.044%
Met	0.0045	0.45%
His	0.0042	0.42%
Phe	0.007	0.7%
Arg	0.012	1.17%
Tyr	0.0079	0.79%
Trp	0.0039	0.39%

Abbreviation: ND: Not detected.

Table S2. 3D-printed serine/glycine-free diet sensory test score sheet

Indicators	Criteria	Rating range	Scoring
Appearance (10 points)	Regular shape (Hexagon)	9–10	
	Slightly lacking in shape (Irregular angles)	6–8	
	Lack of shape (Irregular boundaries)	3–5	
	Shapeless (Not hexagonal)	0–2	
Texture (10 points)	Tight lines, moderate texture, no dents	9–10	
	Lines with clearance, slightly soft or slightly hard texture, no dents	6–8	
	Lines with clearance, slightly soft or slightly hard texture, slightly concave	3–5	
	Lines with clearance, too soft or too hard, obvious concave	0–2	
Flavor (10 points)	Moderate saltiness, with strawberry flavor and no off flavors	9–10	
	Slightly salty or light in taste, no strawberry flavor, no off flavors	5–8	
	Taste too salty or too light, no strawberry flavor, no off flavors	3–5	
	No taste, no strawberry taste, has a peculiar smell	0–2	
Smell (10 points)	Strong strawberry aroma	9–10	
	Slightly strong strawberry aroma	5–8	
	Slight strawberry aroma	3–5	
	No smell of strawberry	0–2	
Overall acceptability		40	

Table S3. 3D-printed serine/glycine-free diet direct swallowing test score sheet

Indicators	Criteria	Rating range	Original diet	3D-printed diet
DEGLUTITION	Swallowing not possible	0		
	Swallowing delayed (>2 sec.) (Solid textures > 10 sec.)	1		
	Swallowing successful	2		
COUGH (involuntary) (before, during, or after swallowing – until 3 minutes later)	Yes	0		
	No	1		
DROOLING	Yes	0		
	No	1		
VOICE CHANGE (listen to the voice before and after swallowing – Patients should speak “O”)	Yes	0		
	No	1		
SUM				

Table S4. Baseline characteristics of the patient cohort (n = 20) for the direct swallowing test

Patient no.	Sex	Age (yr)	BMI (kg/m ³)	NRS-2002	Tumor type	Primary lesion and metastatic sites	Stage	Surgical resection history	Current anti-tumor treatments	Days of –SG diet	Response
1	Male	70	24.02	2	COAD	Colon, liver, LNs	IVB	Yes	Chemotherapy, –SG diet	68	SD
2	Male	69	20.76	1	READ	Rectum, LNs	IVA	No	Chemotherapy, –SG diet	75	SD
3	Male	66	23.23	1	READ	Rectum, liver, LNs	IVA	Yes	Chemotherapy, –SG diet	102	PR
4	Male	68	22.19	2	COAD&READ	Colon, rectum, liver, LNs	IVA	No	Chemotherapy, –SG diet	96	SD
5	Female	64	25.97	1	READ	Rectum, lung	IVA	Yes	Chemotherapy, –SG diet	22	SD
6	Male	52	22.44	1	READ	Rectum, lung, LNs	IVA	Yes	Chemotherapy, –SG diet	84	SD
7	Female	67	18.62	1	COAD	Colon, lung, LNs	IVB	No	Chemotherapy, –SG diet	83	SD
8	Female	57	20.50	1	READ	Rectum, liver, LNs	IVA	Yes	Chemotherapy, –SG diet	114	SD
9	Female	69	22.10	1	READ	Rectum, lung, LNs	IVA	Yes	Chemotherapy, –SG diet	70	SD
10	Male	68	19.56	2	COAD	Colon, liver, LNs	IVB	No	Chemotherapy, –SG diet	93	PD
11	Male	69	19.65	2	STAD	Stomach, LNs	IVB	No	Chemotherapy, immunotherapy, –SG diet	114	PR
12	Female	60	21.31	1	STAD	Stomach, Peritoneum, LNs	IVB	No	Chemotherapy, immunotherapy, –SG diet	83	SD
13	Female	68	24.70	1	LIHC	Liver, peritoneum, LNs	IVB	No	Chemotherapy, immunotherapy, –SG diet	75	SD
14	Male	65	18.70	1	LUSC	Lung, LNs	IIIB	No	Chemotherapy, immunotherapy, –SG diet	84	SD
15	Female	69	24.31	1	SCLC	Lung, liver, bone, adrenal gland, LNs	IVB	No	Chemotherapy, immunotherapy, –SG diet	78	PD
16	Male	68	18.59	2	SCLC	Lung, liver, LNs	IVB	No	Chemotherapy, immunotherapy, –SG diet	77	PR
17	Male	67	27.36	2	SCLC	Lung, LNs	IIIC	No	Chemotherapy, immunotherapy, –SG diet	88	PR
18	Male	69	18.75	1	ESCA	Esophagus, LNs	IIIB	No	Chemotherapy, immunotherapy, –SG diet	50	SD
19	Male	68	19.03	2	ESCA	Esophagus, LNs	III	No	Chemotherapy, immunotherapy, –SG diet	46	SD
20	Male	70	23.05	2	ESCA	Esophagus, LNs	IVA	No	Chemotherapy, immunotherapy, –SG diet	94	SD

Abbreviations: –SG: Serine/glycine-free; BMI: Body mass index; COAD: colon adenocarcinoma; ESCA: esophageal carcinoma; LIHC: liver hepatocellular carcinoma; LN: lymph node; LUSC: lung squamous cell carcinoma; PR: partial response; READ: rectal adenocarcinoma; SCLC: small cell lung cancer; SD: stable disease; STAD: stomach adenocarcinoma.

Table S5. Sensory evaluation for pre- or post-3D-printed diet

Indicators	Rating range	Products		<i>p</i> -value (unpaired <i>t</i> -test)	<i>p</i> -value (paired <i>t</i> -test)
		Original diet	3D-printed diet		
Appearance	0–10	6.53 (0.74)	8.12 (0.83)	<0.0001	<0.0001
Texture	0–10	6.95 (0.65)	8.07 (0.93)	<0.0001	0.0002
Flavor	0–10	7.27 (0.85)	8.12 (0.84)	0.0029	0.0057
Smell	0–10	6.88 (0.8)	8.05 (0.63)	<0.0001	<0.0001
Overall acceptability	0–40	27.63 (1.59)	32.35 (1.69)	<0.0001	<0.0001

Note: Scores are expressed as mean (standard deviation).

Table S6. Direct swallowing test between the original and 3D-printed diet

Indicators	Rating range	Products		<i>p</i> -value (unpaired <i>t</i> -test)	<i>p</i> -value (paired <i>t</i> -test)
		Original diet	3D-printed diet		
DEGLUTITION	0–2	1.8 (0.41)	1.85 (0.37)	0.6867	0.3299
COUGH (involuntary) (before, during, or after swallowing – until 3 minutes later)	0–1	0.45 (0.51)	1 (0)	<0.0001	0.0001
DROOLING	0–1	0.95 (0.22)	1 (0)	0.3236	0.3299
VOICE CHANGE (listen to the voice before and after swallowing – Patients should speak “O”)	0–1	0.95 (0.22)	1 (0)	0.3236	0.3299
SUM	0–5	4.2 (0.83)	4.8 (0.41)	0.0064	0.0003

Note: Scores are expressed as mean (standard deviation).

Table S7 Experimental results of a 3D-printed serine/glycine-free diet.

Ink	A Chitosan powder (%)	B Xanthan gum (‰)	C Printing speed (mm/s)	D Fill rate (%)
1	0.75	0.75	25	100
2	1.25	1.25	25	80
3	1.25	1.25	30	100
4	3.75	1.25	25	100
5	1.25	3.75	25	100
6	1.25	1.25	20	100
7	0	1.25	25	100
8	1.25	0	25	100
9	3.75	3.75	25	100
10	1.25	1.25	25	100
11	1.25	1.25	25	90

The percentage of shell powder and xanthan gum is the ratio of the total mass of water and amino acids. Ink10 is the optimal formula.