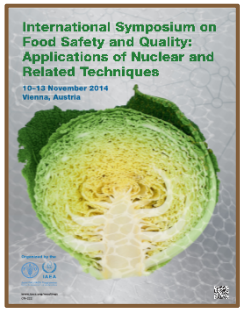

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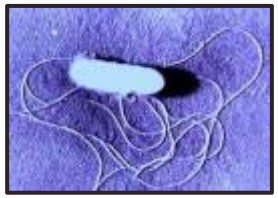
Faculty of Food Science

Use of irradiation to provide wider selection of foods for immuno-compromised patients

Csilla Mohácsi-Farkas

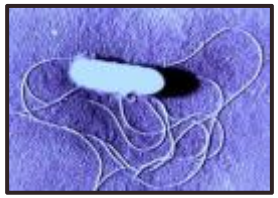






Immuno-compromised diet

- Steril diet (autoclaving / irradiation)
- „Clean” (low microbial count / neutropenic) diet
- Diet prepared under „normal” hygienic conditions



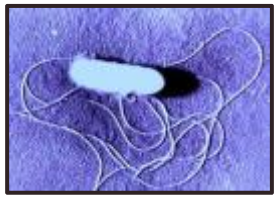




FAO/IAEA Co-ordinated Research Project (CRP): Development of Irradiated Foods for Immuno-compromised Patients and Other Potential Target Groups 2010-2015.

Aim of our studies

- to determine the radiation doses provide microbiological safety of selected products without diminishing the quality/ nutritional/ sensory parameters;







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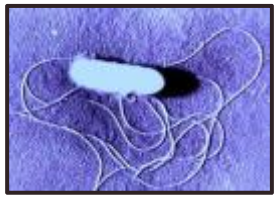
Neutropenic diet

Microbiological criteria suggested by the CRP

- Total plate count < 500 cfu/g
- *Listeria* spp. absent in 25 g
- *Salmonella* spp. absent in 25 g
- Yeasts and moulds < 50 cfu/g
- Coliforms < 10 cfu/g
- Coagulase-positive *Staphylococcus aureus* < 10 cfu/g
- Aerobic spore count < 10 cfu/g
- Anaerobic spore count < 10 cfu/g (absent in 25 g)



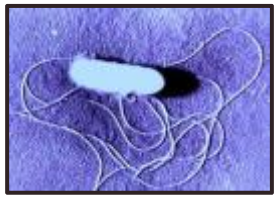




Survey of Hungarian institutional practices for dietary restrictions for immuno-suppressed patients

Foods which cannot be sterilized by heating, but are most frequently requested by patients:

- **Milk and dairy products** – Túró Rudi (a special Hungarian cottage cheese dessert), cottage cheese, cream cheese
- **Vegetables** – bell peppers, tomatoes, radishes, onions, cucumbers, lettuce
- **Fruit** – apples, pears, strawberry, raspberry, blackberry, grapes, citrus and tropical fruits
- **Dessert** – jelly rolls, sponge cake, diabetic desserts
- **Nuts** – almonds, peanuts
- **Other** – breaded steak

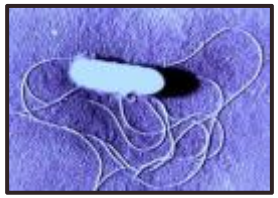






Products selected/examined

- ✓Fresh-cut fruits
  - ✓ apple (cultivar Golden, Idared, Granny Smith), orange, banana
- ✓Fresh-cut vegetables
  - ✓ tomato, carrot
- ✓Dairy products
  - ✓cottage cheese cream, Túró Rudi
- ✓Dessert
  - ✓raspberry - chestnut puree - sponge cake dessert
- ✓Fruit-puree ice cream
  - ✓raspberry-banana sorbet







Examinations of

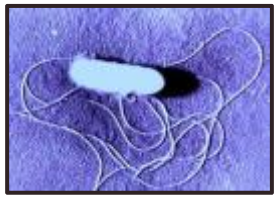
✓changes in natural microbiota after irradiation and during refrigerated/frozen storage

- ✓radiation dose: 0.5-3.0 kGy
- ✓AGROSTER Zrt., Budapest, Hungary

✓sensorically acceptable radiation dose (colour, odour, taste, texture)

✓changes in nutritionally important components (antioxidant vitamins, fatty acid composition)

✓challenge tests with *Listeria* strains

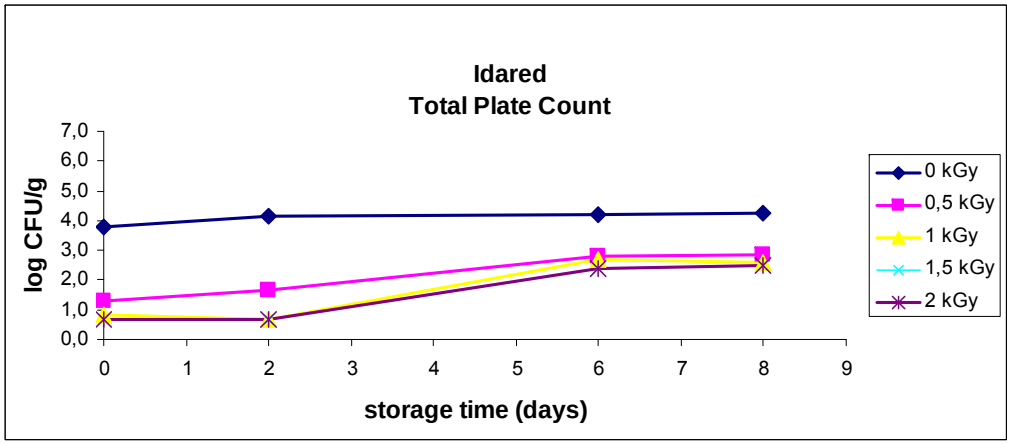




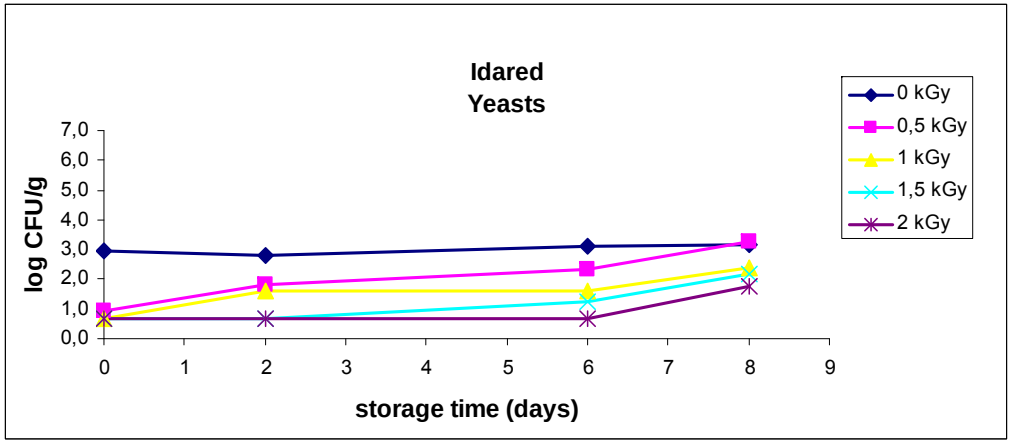


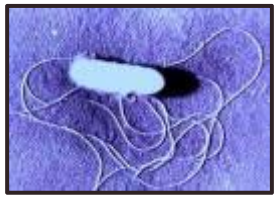
Pre-cut fruits - apple

Results



Storage temperature: 5 °C









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Use of irradiation to provide wider selection of foods for immuno-compromised patients

Pre-cut fruits - apple

Results

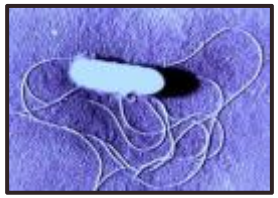
- Irradiation with 2 kGy dose could provide appropriate low microbial counts of fresh-cut apple.
- Refrigerated storage (5 °C) of irradiated cut/sliced fruits is recommended not longer than 5 days.
- According to Kramer's rank test, statistically significant differences in organoleptic properties (colour, odour, taste and texture) were not found at doses up to 2 kGy.

Pre-cut fruits - apple

Results

- After irradiation with doses up to 2 kGy, there was no clear tendecy in dose dependent response of total polyphenol content and antioxidant capacity.

- Careful sorting of apple cultivars for preparing fruit salad is recommended.
  - Among the apple varieties tested, Idared and Golden Delicious are suitable for preparing fresh-cut salads.

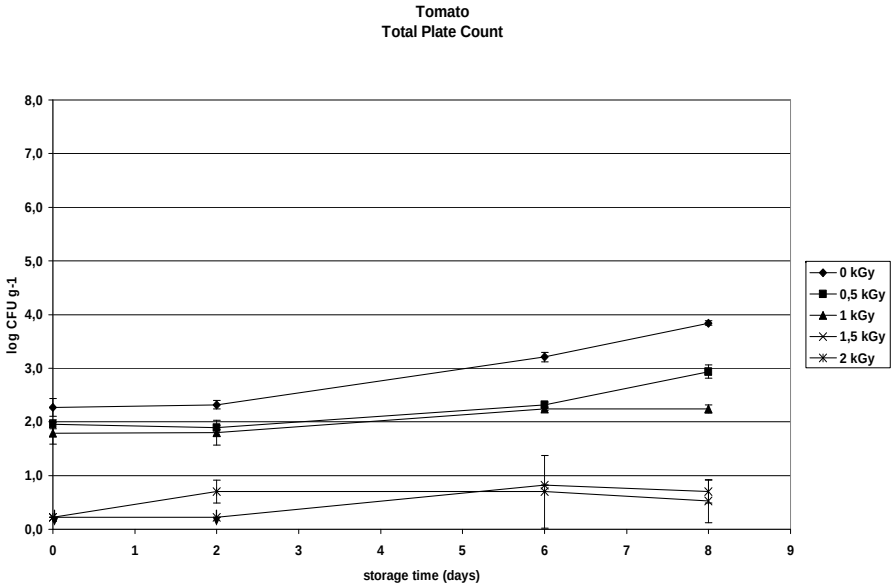


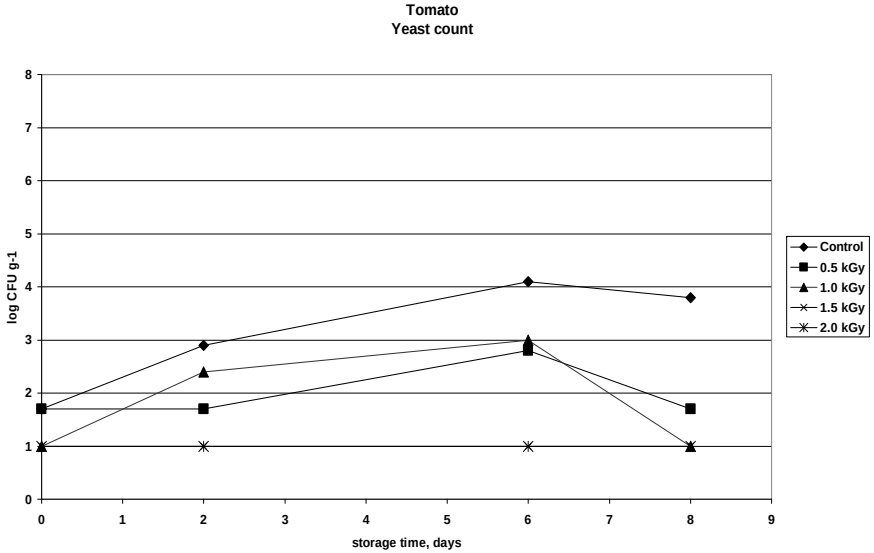




Pre-cut vegetables - tomato

Results





- Based upon the microbiological criteria suggested by the CRP, irradiation of tomato salad with 2 kGy dose could provide appropriate low microbial counts.
- Samples remain microbiologically safe during 8 days of refrigerated (5 °C) storage.

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Use of irradiation to provide wider selection of foods for immuno-compromised patients

Pre-cut vegetables - tomato

Results

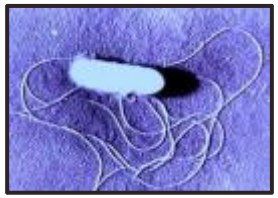
Sensory testing of sliced tomato (15 panelists)

Radiation dose (kGy)	Score means								Rank sums			
	Colour		Odour		Taste		Texture		Colour	Odour	Taste	Texture
0	7.87	±1.13	7.20	±1.97	7.13	±2.10	7.13	±1.85	27.00	24.50	23.00	25.50
1	7.60	±1.60	6.27	±2.22	5.60	±2.16	6.60	±1.40	31.50	30.00	34.00	32.50
2	7.60	±0.99	6.13	±2.56	5.67	±2.85	6.73	±1.44	31.50	35.50	33.00	32.00

** rank sums within the range 22-38 are not significantly different at α ≤ 0.01 probability level

* rank sums within the range 23-37 are not significantly different at α ≤ 0.05 probability level

- According to Kramer's rank test, statistically significant differences between unirradiated and irradiated samples were not observed.







Pre-cut vegetables - tomato

Results

Effect of gamma irradiation on carotenoids, tocopherols and ascorbic acid content of pre-cut tomatoes

	Concentration µg/g fresh produce						
	Zeaxanthin	Licoxanthin	Lycopene	9Z+13Z lycopene	β-carotene	ζ- carotene	Fitoin
0 kGy	0.13±0.01	0.24±0.02	15.99±0.47	4.67±0.24	2.15±0.19	0.34±0.03	0.81±0.01
2 kGy	0.08±0.00*	0.25±0.04	13.92±0.84*	3.04±0.04*	1.77±0.08*	0.23±0.01*	0.53±0.40

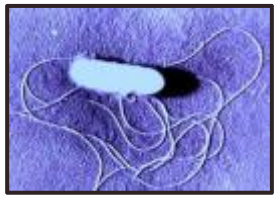
Tocopherols	Concentration µg/g fresh produce			
	α-Tocopherol	β-Tocopherol	γ-Tocopherol	δ-Tocopherol
0 kGy	4.44±0.03	0.31±0.00	2.88±0.15	0.15±0.01
2 kGy	2.86±0.01*	0.34±0.01	2.63±0.01	0.15±0.01

Ascorbic acid content	Concentration µg/g fresh produce
0 kGy	61.71±0.33
1 kGy	56.07±0.46*

* significantly different at α ≤ 0.05 probability level

- Although losses in carotenoids, tocopherols and ascorbic acid content were statistically significant, they are less than the natural variation that may be found between varieties of produce and at different post-harvest conditions.

Mohácsi-Farkas et al. (2014) RPC 99, 79-85.







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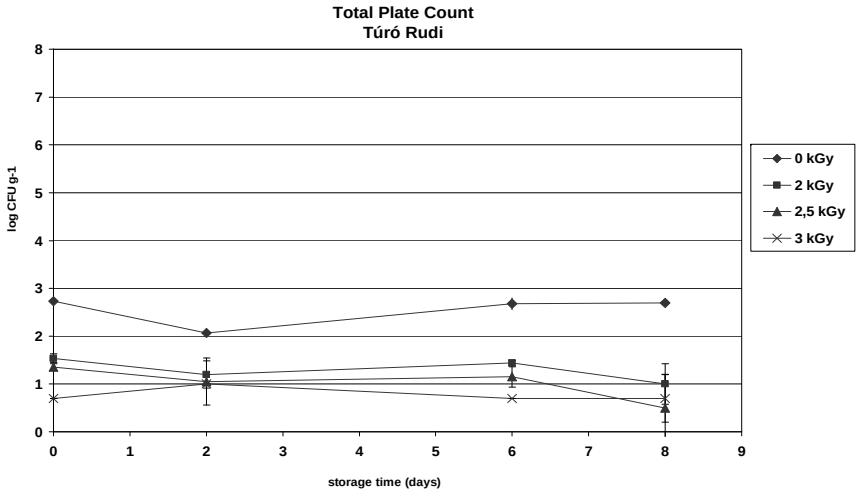
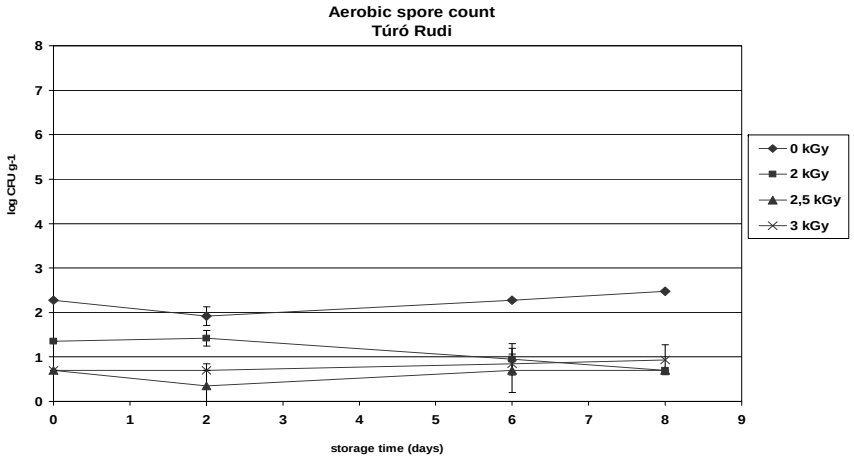
Use of irradiation to provide wider selection of foods for immuno-compromised patients

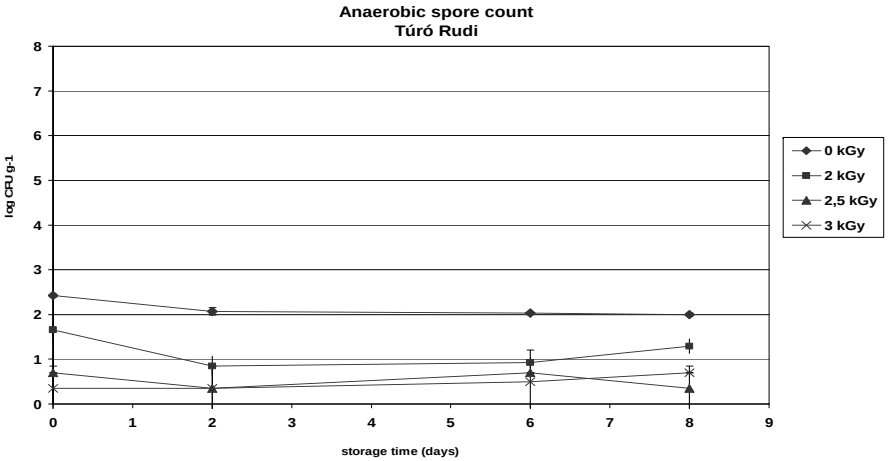
Dairy products - Túró Rudi

Results



Radiation treatment in frozen form,
Storage at 5 °C





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Use of irradiation to provide wider selection of foods for immuno-compromised patients

Dairy products- Túró Rudi — Results

Microbiological evaluation

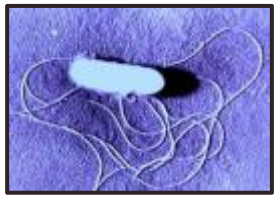
- Irradiation of frozen Túró Rudi with 3.0 kGy dose could provide appropriate low microbial counts.
- Samples remain microbiologically safe during 8 days of refrigerated storage.

Sensory testing

Sensory testing of Túró Rudi (12 panelists)

Radiation dose (kGy)	Score means								Rank sums			
	Colour		Odour		Taste		Texture		Colour	Odour	Taste	Texture
0	8.67	±0.65	8.00	±1.21	6.25	±1.91	7.83	±1.27	32.00	30.00	28.50	30.50
2.0	8.33	±2.02	8.42	±0.67	8.00	±1.13	7.92	±1.44	30.50	26.00	20.50*	27.00
2.5	8.83	±0.39	7.83	±1.47	5.75	±2.22	7.75	±1.22	29.50	30.00	36.00	32.00
3.0	8.92	±0.29	7.75	±1.22	5.50	±2.68	7.83	±1.53	28.00	34.00	35.00	30.50

** rank sums within the range 19-41 are not significantly different at α ≤ 0.01 probability level
* rank sums within the range 21-39 are not significantly different at α ≤ 0.05 probability level







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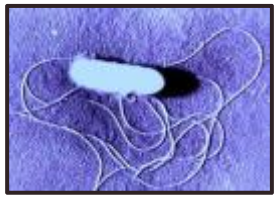
Use of irradiation to provide wider selection of foods for immuno-compromised patients

Dairy products- Túró Rudi

Results

Determination of lipid oxidation:

- Coating chocolate part (39.1%) and filling cottage cheese part (60.9%) were analysed separately.
- Statistical evaluation of fatty acid analysis data showed no significant changes in fatty acid composition of dairy products due to irradiation up to 3 kGy dose.
- These results indicate that undesirable lipid oxidation did not occur in irradiated samples.

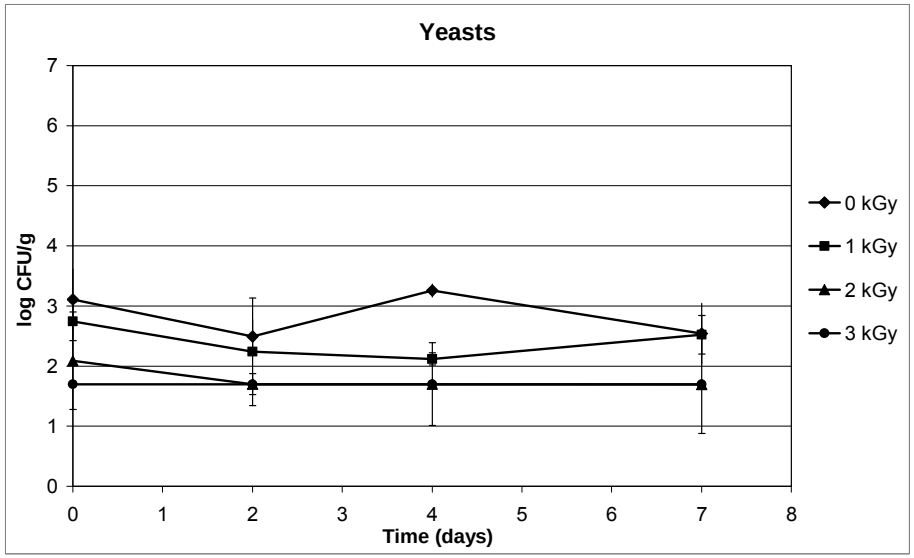


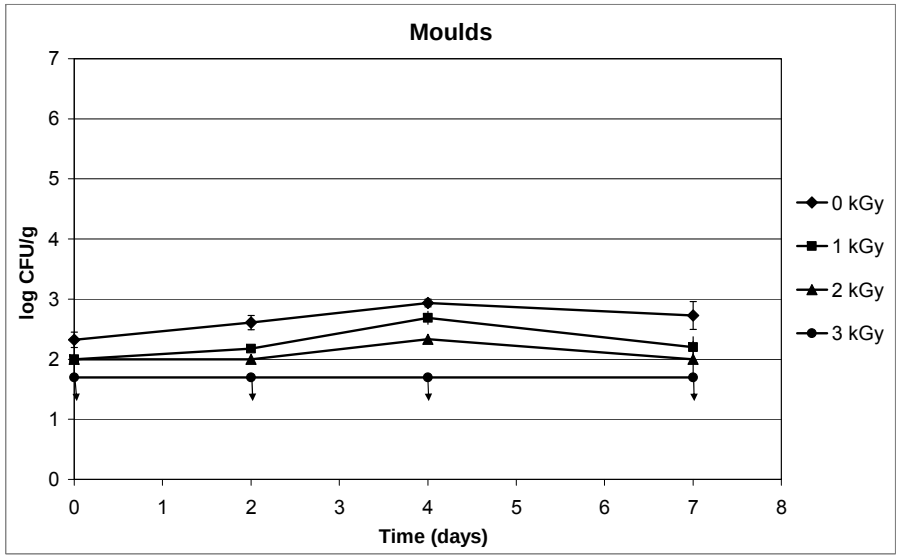




Dessert food items – raspberry puree

Results





Radiation treatment and storage at -18 °C

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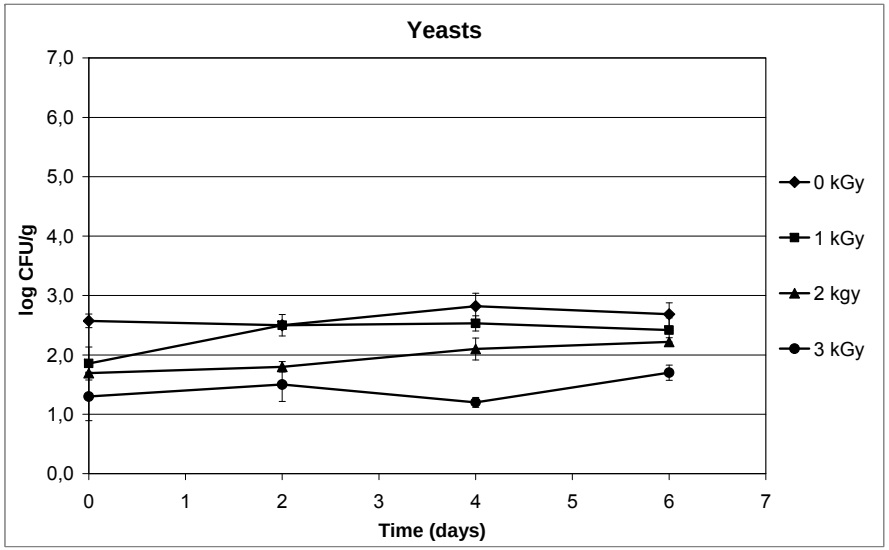
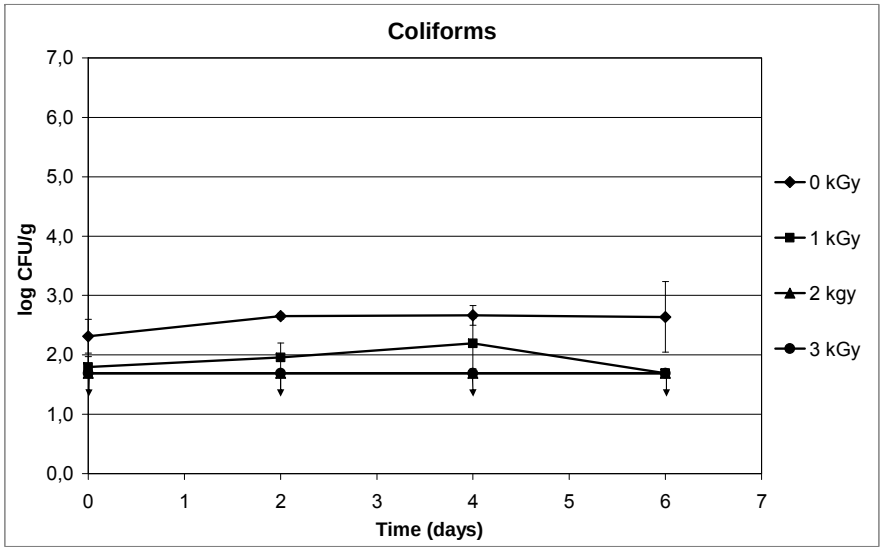
Use of irradiation to provide wider selection of foods for immuno-compromised patients

Dessert food items – sweet chestnut puree Results





Radiation treatment and storage at -18 °C

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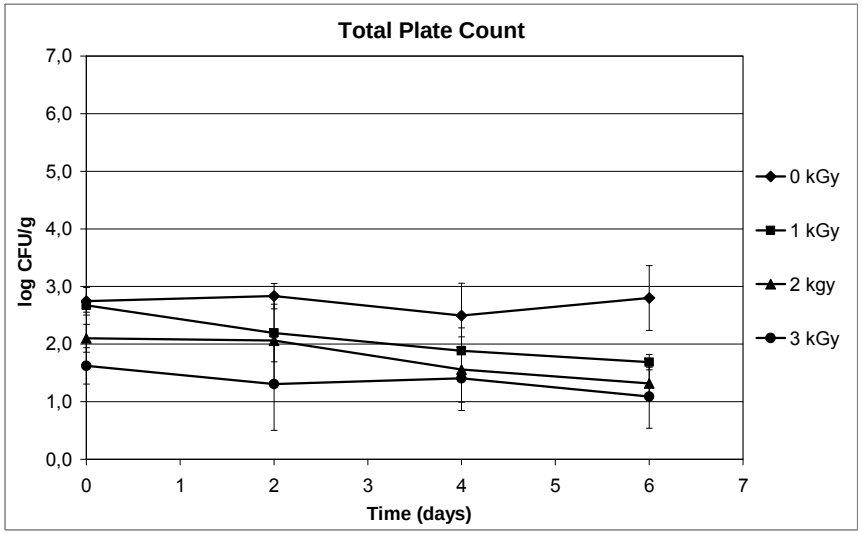
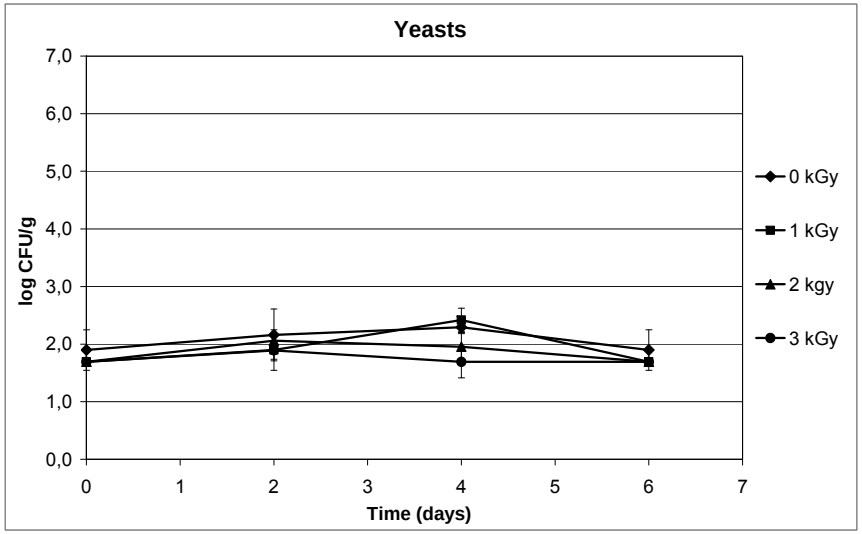
Use of irradiation to provide wider selection of foods for immuno-compromised patients

Dessert food items – sponge cake

Results





Radiation treatment and storage at -18 °C

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Use of irradiation to provide wider selection of foods for immuno-compromised patients

Dessert food

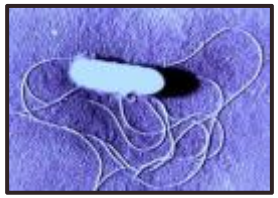
Results

Sensory testing of chestnut-raspberry dessert (19 panelists)

Radiation dose (kGy)	Score means								Rank sums			
	Colour		Odour		Taste		Texture		Colour	Odour	Taste	Texture
0	8.32	±0.89	8.05	±0.91	8.37	±1.26	8.05	±1.08	28.00*	24.50*	24.50*	28.50*
2	6.84	±6.58	5.74	±2.35	6.79	±1.72	7.00	±1.73	44.00	45.00	42.50	42.50
3	6.58	±2.22	5.63	±2.36	6.53	±1.58	6.79	±2.02	42.00	44.50	47.00*	43.00

* rank sums within the range 30-46 are not significantly different at α ≤ 0.05 probability level

- Score means given by the members (healthy adults) were above 5.6 in all samples;
- Very high variations in scores of all irradiated samples show the individual sensitivity of panelists;
- Written comments: most of them found “very good” all samples. The relatively low scores for odour properties of irradiated desserts were due to the off-odour of sweet chestnut puree part.







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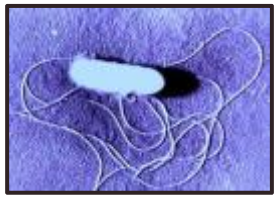
Use of irradiation to provide wider selection of foods for immuno-compromised patients

Challenge tests

Bacterial strains used for inoculation studies:

Listeria innocua (formerly identified as *L. monocytogenes* 4ab No. 10, an avirulent strain, obtained from Dr. B. Ralovich, Hungarian Meat Research Institute)

Listeria monocytogenes Scott A, obtained from ATO-DLO, Wageningen, The Netherlands

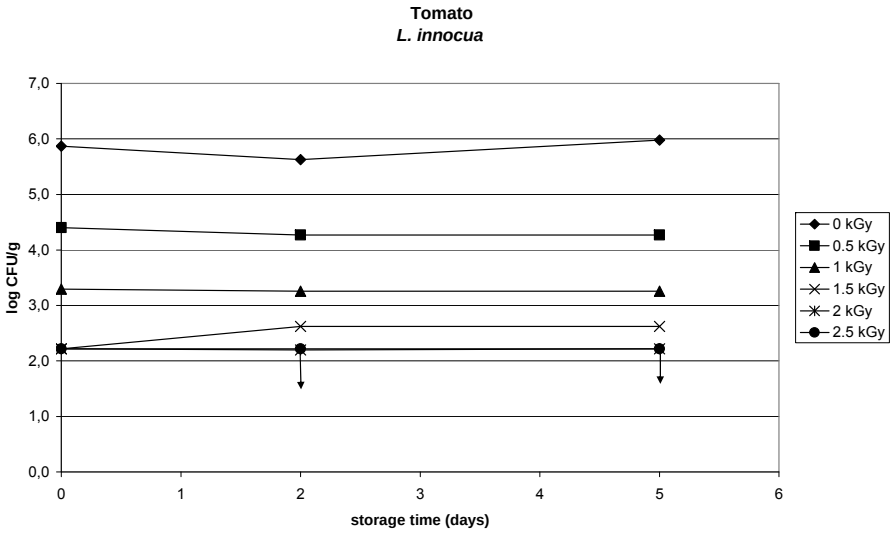


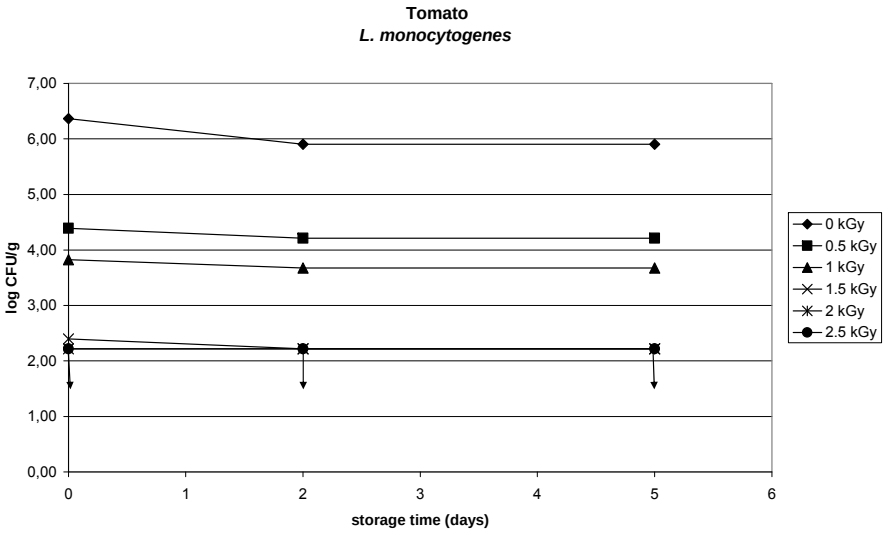




Challenge tests

Results





Effect of irradiation on the survival and growth of *Listeria innocua* and *Listeria monocytogenes* ScottA inoculated on pre-cut tomato (initial pH 4.0±0.2) stored at 5 °C

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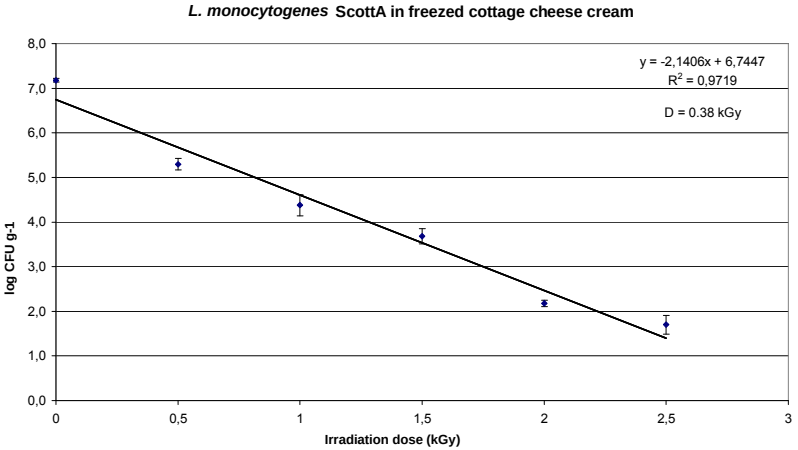
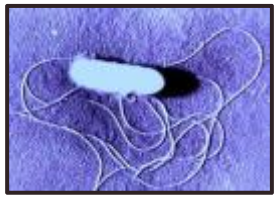
Use of irradiation to provide wider selection of foods for immuno-compromised patients

Challenge tests

Results

Product	D_{10}-value (kGy)	
	L. monocytogenes Scott A	*L. innocua*
Refrigerated cottage cheese	0.32	0.29
Frozen cottage cheese	0.38	0.49
Pre-cut tomato	0.40	0.39
Phosphate buffer (pH 7.0)		0.40
Alfalfa sprout		0.46
Phosphate buffer (Patterson, 1989)	0.32-0.49	
Ice cream at -72 ºC (Kamat et al., 2000)	0.38	
Ice cream at 0 ºC (Kamat et al., 2000)	0.25	









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Use of irradiation to provide wider selection of foods for immuno-compromised patients

Important task:

Education to increase acceptance of the technology

- Workshops to inform health care professionals (dietitians, nutritionists, nurses) on the use of irradiated food in hospital diets;
- Education of the general public concerning the safety of food irradiation;
- Cost-benefit analysis of enhanced microbiological safety to provide decision makers a sound basis to plan infrastructure of the supporting services of the immuno-compromised patients;
- www.foodirradiation.eu (in Hungarian)
  - „willingness to pay” survey for immuno-compromised patients
- https://www.facebook.com/elelmiszerbesugarzas


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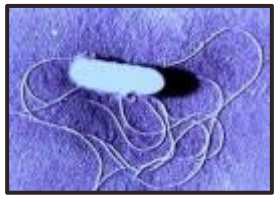
Élelmiszerek besugárzása
Jótékony sugarak az élelmiszerek biztonsága és minősége szolgálatában
A patogén baktériumok okozta élelmiszer eredetű megbetegedések világszerte egyre növekvő problémát jelentenek, amely különösen veszélyes a legyengült immunrendszerű emberek számára. A patogének gátlása és pusztítása, valamint az ellenállóság növelése érdekében az élelmiszeripar számos eljárást fejlesztett ki, többek között a különböző sugárzással történő kezeléseket.
Annak ellenére, hogy olyan nemzetközi testületek hagyták jóvá, mint az Egészségügyi Világszervezet (WHO), valamint az Élelmezési- és Mezőgazdasági Szervezet (FAO), az élelmiszer-besugárzás csak lassan halad az elfogadottság felé Európában. Feltehetően a probléma a besugárzással kapcsolatos, szegényes kommunikációban rejlik. A hiteles információknak az élelmiszerek biztonságának növelése által felvállalt előnyöket kellene bemutatni, amik igen alacsony mikrobaszámú élelmiszerek előállítását teszik lehetővé.
Az élelmiszerek sugárkezelésére (besugárzására) ionizáló sugárzást használnak, ^{60}Co vagy ^{137}Cs izotópok gamma sugarainak vagy Röntgen-sugaraknak, ill. nagy energiájú elektronoknak kitéve azokat.
Az eljárás egyik jellemzője, hogy a besugárzás során elhanyagolhatóan csekély hőmérsékletnövekedés lép fel, ami az élelmiszerekben, és így hasznos tápanyagaikban hőkárosodást nem okoz. Vizsgálatok mutatták ki, hogy nincs szignifikáns veszteség a tápanyagok mennyiségében a besugárzást követően.
Miután fizikai eljárásról van szó, nincsenek az egészségre ártalmas szermaradványok, tartósítószerek. A termék maga – hasonlóképpen ellentétben – nem válik radioaktívvá.
A besugárzás mikrobiológiailag stabil élelmiszerek előállítását teszi lehetővé, segítségével biztonságosan elpusztíthatók a baktériumok mellett a penészgombák is.







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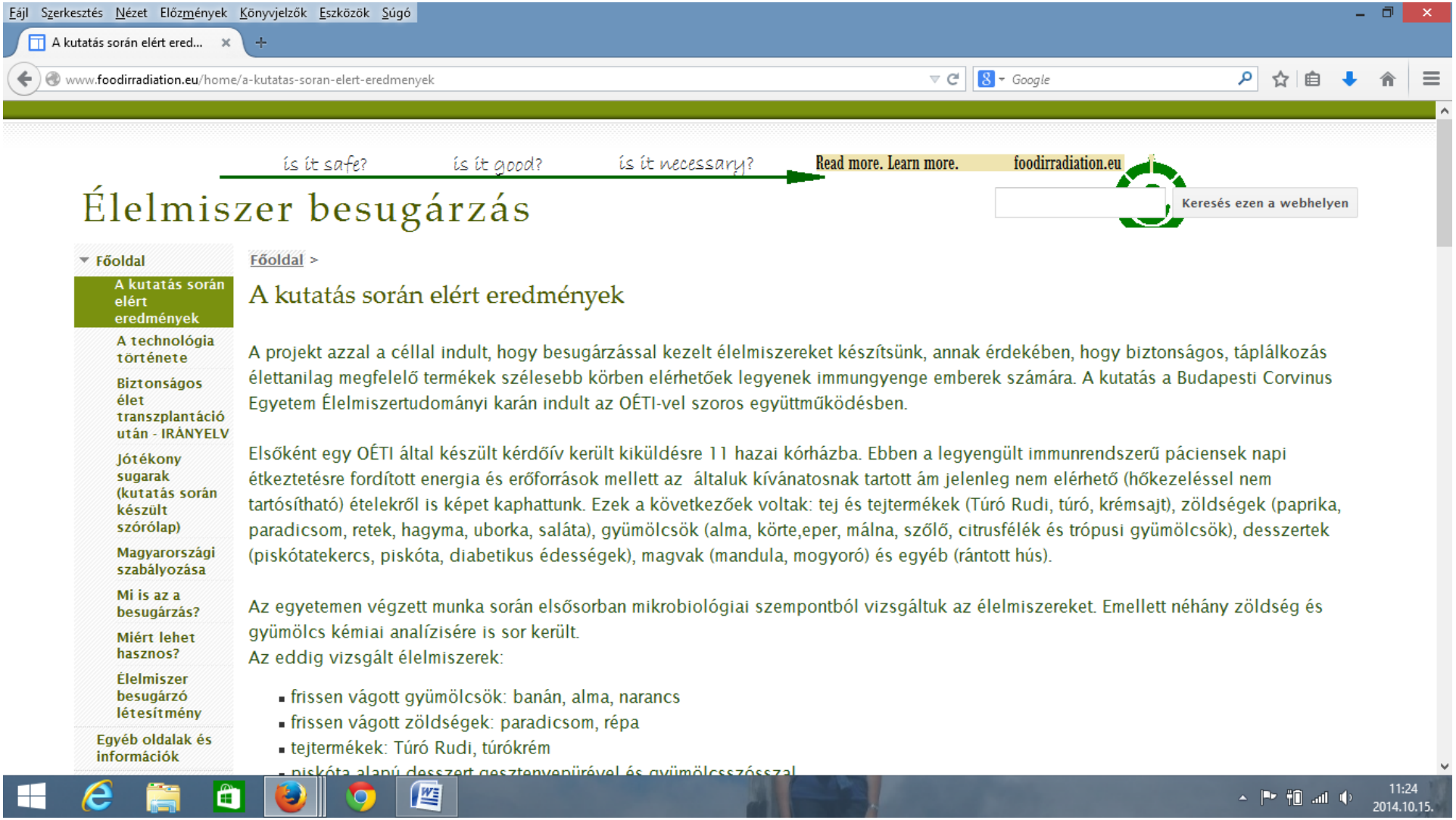
Use of irradiation to provide wider selection of foods for immuno-compromised patients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Élelmiszer besugárzás
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A technológia története
Biztonságos élet transzplantáció után - IRÁNYELV
Jótékony sugarak (kutatás során készült szórólap)
Magyarországi szabályozása
Mi is az a besugárzás?
Miért lehet hasznos?
Élelmiszer besugárzó létesítmény
Egyéb oldalak és információk
Főoldal >
A kutatás során elért eredmények
A projekt azzal a céllal indult, hogy besugárzással kezelt élelmiszereket készítsünk, annak érdekében, hogy biztonságos, táplálkozás élettanilag megfelelő termékek szélesebb körben elérhetőek legyenek immungyenge emberek számára. A kutatás a Budapesti Corvinus Egyetem Élelmiszertudományi karán indult az OÉTI-vel szoros együttműködésben.
Elsőként egy OÉTI által készült kérdőív került kiküldésre 11 hazai kórházba. Ebben a legyengült immunrendszerű páciensek napi étkeztetésre fordított energia és erőforrások mellett az általuk kívánatosnak tartott ám jelenleg nem elérhető (hőkezeléssel nem tartósítható) ételekről is képet kaphattunk. Ezek a következőek voltak: tej és tejtermékek (Túró Rudi, túró, krémsajt), zöldségek (paprika, paradicsom, retek, hagyma, uborka, saláta), gyümölcsök (alma, körte,eper, málna, szőlő, citrusfélék és trópusi gyümölcsök), desszertek (piskótatekercs, piskóta, diabetikus édességek), magvak (mandula, mogyoró) és egyéb (rántott hús).
Az egyetemen végzett munka során elsősorban mikrobiológiai szempontból vizsgáltuk az élelmiszereket. Emellett néhány zöldség és gyümölcs kémiai analízisére is sor került.
Az eddig vizsgált élelmiszerek:
frissen vágott gyümölcsök: banán, alma, narancs
frissen vágott zöldségek: paradicsom, répa
tejtermékek: Túró Rudi, túrókrém
11:24
2014.10.15.

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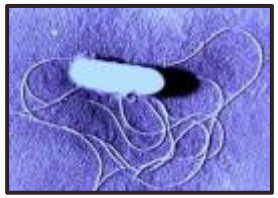





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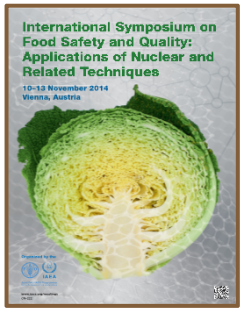

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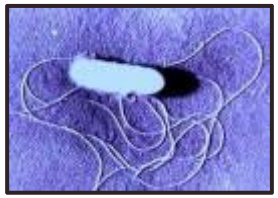





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