

Daging Kultur Menurut Perspektif Islam: Analisis terhadap Penggunaan ESCs sebagai Sumber Sel Stem

Cultured Meat in Islamic Perspective: An Analysis to the Use of ESCs as Source of Stem Cell

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Abstrak

Perkembangan sains dan teknologi telah memberikan pelbagai kemudahan kepada manusia dalam pelbagai aspek kehidupan. Antaranya penghasilan daging tanpa melibatkan penternakan lembu secara konvensional yang dinamakan sebagai daging kultur. Daging ini dihasilkan di dalam makmal dengan mengembangkan sel stem sehingga menjadi daging kultur. Daging ini berpotensi untuk dipasarkan namun perlu menepati prinsip Islam apabila ia ingin dipasarkan kepada pengguna beragama Islam yang diketahui menjadi antara pengguna terbesar dalam pasaran daging. Kajian ini akan melihat konsep daging kultur secara umum, sejarah dan teknik yang digunakan. Seterusnya, pengkaji akan melihat status halal daging kultur berdasarkan sumber Sel Stem Embrio (ESCs) kerana ia adalah sumber terbaik dalam pengkulturan daging. Hasil kajian mendapati jika sel stem diambil dari lembu yang telah disembelih mengikut kaedah yang telah ditetapkan oleh Islam, maka daging kultur tersebut halal dimakan.

Katakunci: Daging Kultur; Sel Stem Embrio (ESC); Sumber Sel Stem; Perspektif Islam

Abstract

The advancement of science and technology has provided various facilities to mankind in various aspects of life. This includes the production of meat without involving conventional cattle breeding known as cultured meat. The meat is produced in the laboratory by expanding the stem cells until the meat becomes cultured. This meat has the potential to be marketed but it has to adhere to the Islamic principles if we wish to market it to Muslim consumers, which are known to be some of the largest consumers in the meat market. This study will look into the concept of cultured meat in general, the history also the technique applied. Next, researcher will look into the halal status of the cultured meat based on the stem cells resources from Embryo Stem Cell (ESCs) because it is the best resource in culturing meat. The study outcome finds that if the stem cells are taken from cows slaughtered according to the method predetermined by Islam, the cultured meat would be halal to eat.

Keywords: Cultured Meat; Embryo Stem Cell (ESC); Source of Stem Cell; Islamic Perspective

Rujukan

- Abadi, M. A. bin A. bin ‘Ali. (2005). Awn al-Ma‘bud ‘ala Sharh Sunan Abi Dawud,. In Al-Albani & Al-Athari (Eds.), . Beirut: Dar Ibn Hazm.
- Abidin, I. (1994). Radd al-Muhtar ‘ala al-Durr al-Mukhtar Sharh Tanwir al-Absar. In Al-Mawjud (Ed.), . Beirut: Dar al-Kutub al-‘Ilmiyyah.
- Abu Dawud, S. bin al-A. (1997). Sunan Abi Dawud. In I. ‘Ubayd Al-Da‘‘as & A. Al-Sayyid (Eds.), . Beirut: Dar Ibn Hazm.
- Al-‘Asqalani, A. bin ‘Ali bin H. (2001). Fath al-Bari. In A. al-Q. S. Al-Hamd (Ed.), . Riyad.
- Al-‘Ayni, M. bin A. (1990). al-Binayah fi Sharh al-Hidayah. Beirut: Dar al-Fikr.
- Al-‘Ayni, M. bin A. (2007). Minhah al-Suluk fi Sharh Tuhfah al-Muluk. In A. ‘Abd al-R. ‘Abdullah Al-Kaybasi (Ed.), . Qatar: Kementerian Wakaf dan Hal Ehwah Islam.
- Al-Ansari, Z. bin M. (1997). al-Ghurur al-Bahiyyah fi Sharh Manzumah al-Bahjah al-Wardiyyah. In M. ‘Abd al-Q. ‘Ata (Ed.), . Beirut: Dar al-Kutub al-‘Ilmiyyah.
- Al-Baghawi, A.-H. bin M. al-B. (1990). Ma‘alim al-Tanzil. In M. ‘Abdullah Al-Namr, U. J. Dumayriyyah, & S. M. Al-Harash (Eds.), . Riyad: Dar Tibah.
- Al-Bayhaqi, A. bin al-H. bin ‘Ali. (2003). Al-Sunan al-Kubra. In M. ‘Abd al-Q. ‘Ata (Ed.), . Beirut: Dar al-Kutub al-‘Ilmiyyah.
- Al-Buhuti, M. bin Y. bin I. al-B. (2000). Sharh Muntaha al-Iradat Daqa’iq Uli al-Nahy li Sharh al-Muntaha. In A. bin ‘Abd al-M. Al-Turki (Ed.), . Beirut: Muassasah al-Risalah.
- Aldous, P. (2006). Print Me a Heart and a Set of Arteries. In New Scientist (p. 19).
- Al-Fawzan, S. bin F. bin ‘Abdullah. (1988). al-At‘‘imah wa Ahkam al-Sayd wa al-Dhaba’’ih. Riyad: Maktabah al-Ma‘arif.
- Al-Jawhari, & Hammad, I. bin. (1990). Al-Sihah Taj al-Lughah wa al-Sihah al-Arabiyyah. In Attar (Ed.), (4th ed.). Kaherah: Dar al-Ilm li al-Malayin.
- Al-Juwayni, A. al-M. bin ‘Abdillah bin Y. (2007). Nihayah al-Matlab fi Dirayah al-Madhhab. In A. al-‘Azim M. Al-Dib (Ed.), . Jeddah: Dar al-Minhaj.
- Al-Kasani, A. al-D. A. B. bin M. (1986). Badai‘ al-Sanai‘ fi Tartib al-Sharai‘. Beirut: Dar al-Kutub al-‘Ilmiyyah.
- Al-Khattabi. (1997). Ma‘alim al-Sunan. In I. ‘Ubayd Al-Da‘‘as & A. Al-Sayyid (Eds.), . Beirut: Dar Ibn Hazm.
- Al-Mawardi, A. bin M. bin H. (1994). al-Hawi al-Kabir fi Fiqh Madhhab al-Imam al-Shafi‘i. In

- A. M. Mu‘awwad & A. A. ‘Abd Al-Mawjud (Eds.), . Beirut: Dar al-Kutub al-‘Ilmiyyah.
- Al-Mubarakfuri, A. al-R. bin ‘Abd al-R. (t.t.). Tuhfah al-Ahwadhi bi Sharh al-Jami ‘al-Tirmidhi. In A. al-W. ‘Abd Al-Latif (Ed.), . Beirut: Dar al-Fikr.
- Al-Nawawi, M. al-D. bin S. (t.t.). Al-Majmu‘ Sharh al-Muhadhdhab. In M. N. Al-Muti‘i (Ed.), . Jeddah: Maktabah al-Irshad.
- Al-Qarafi, & Idris, S. al-D. A. bin. (1994). Al-Dhakhirah. In Muhammad Bukhubzah (Ed.), . Beirut: Dar al-Gharb al-Islami.
- Al-Qayrawani, & Al-Rahman, A. bin ‘Abd. (1999). al-Nawadir wa al-Ziyadat ‘ala ma fi al-Mudawwanah min Ghayriha min al-Ummahat. In M. Hajji (Ed.), . Beirut: Dar al-Gharb al-Islami.
- Al-Qurtubi. (1996). al-Mufhim lima Ashkala min Talkhis Kitab Muslim. In M. al-D. D. Mistu (Ed.), . Damascus: Dar Ibn Kathir.
- Al-Qurtubi, M. bin A. bin A. B. (2006). Al-Jami“ li Ahkam al-Qur”an. In A. bin ‘Abd al-M. Al-Turki (Ed.), . Beirut: Muassasah al-Risalah.
- Al-Rafi‘i, A. al-K. M. bin ‘Abd al-K. (1997). al-‘Aziz Sharh al-Wajiz al-Ma‘ruf bi al-Sharh al-Kabir. In A. M. Mu‘awwad & A. A. ‘Abd Al-Mawjud (Eds.), . Beirut: Dar al-Kutub al-‘Ilmiyyah.
- Al-Sarakhsi, S. al-D. (t.t.). al-Mabsut. Beirut: Dar al-Ma‘rifah.
- Al-Shafi’i, M. bin I. (2001). al-Umm. In R. Fawzi (Ed.), . Mansurah: Dar al-Wafa’.
- Al-Shawkani, M. bin ‘Ali. (2006). Nayl al-Awtar min Asrar Muntaqa al-Akhbar. In M. S. bin H. Hallaq (Ed.), . Dammam: Dar Ibn al-Jawzi.
- Al-Shirbini, M. bin al-K. (1997). Mughni al-Muhtaj ila Ma‘rifah Alfaz al-Minhaj. In M. K. ‘Aytani (Ed.), . Beirut: Dar al-Ma‘rifah.
- Al-Tabari, M. bin J. (t.t.). Jami“ al-Bayan ‘an Ta’wil Ayi al-Qur”an. In M. M. Shakir & A. M. Shakir (Eds.), . Cairo: Maktabah Ibn Taimiyyah.
- Al-Tirmidhi, M. bin ‘Isa bin S. (1996). Sunan al-Tirmidhi. In al-Albani et al. (Ed.), (p. 350). Riyadh: Maktabah al-Ma‘arif.
- Al-Zayla‘i, U. bin ‘Ali. (1897). Tabyin al-Haqa’iq Sharh Kanz al-Daqa’iq. Cairo: Matba‘ah al-Kubra al-Amiriyyah.
- Anas, M. bin. (t.t.). al-Mudawwanah al-Kubra. Riyadh: Kementerian Hal Ehwal Islam, Wakaf, Dakwah dan Irshad.
- Anas, M. bin. (1997). al-Muwatta’. In Bashshar ‘Awwad Ma‘ruf (Ed.), . Beirut: Dar al-Gharb al-Islami.

Beef, C. (2013). Burger Tasting London. Retrieved November 17, 2014, from http://www.youtube.com/watch?v=_Cy2x2QR968

Beer, E. (2014). Global Halal Market to Hit 1.6tn USD by 2018. Retrieved October 7, 2014, from <http://www.foodnavigator.com/Regions/Middle-East/Global-Halal-market-to-hit-1.6tn-by-2018>

Benjaminson, M. a., Gilchrist, J. a., & Lorenz, M. (2002). In vitro edible muscle protein production system (MPPS): Stage 1, fish. *Acta Astronautica*, 51(12), 879–889. [http://doi.org/10.1016/S0094-5765\(02\)00033-4](http://doi.org/10.1016/S0094-5765(02)00033-4)

Bhat, Z. F., & Bhat, H. (2011). Animal-free meat biofabrication. *American Journal of Food Technology*, 6(6), 441–459. <http://doi.org/10.3923/ajft.2011.441.459>

Bhat, Z. F., Bhat, H., & Pathak, V. (2014). Prospects for In Vitro Cultured Meat – A Future Harvest. *Principles of Tissue Engineering (Fourth Ed)*. Elsevier. <http://doi.org/10.1016/B978-0-12-398358-9.00079-3>

Bhat, Z. F., & Fayaz, H. (2011). Prospectus of cultured meat—advancing meat alternatives. *Journal of Food Science and Technology*, 48(2), 125–140. <http://doi.org/10.1007/s13197-010-0198-7>

Bhat, Z. F., Kumar, S., & Fayaz, H. (2015). In vitro meat production: Challenges and benefits over conventional meat production. *Journal of Integrative Agriculture*, 14(2), 241–248. [http://doi.org/10.1016/S2095-3119\(14\)60887-X](http://doi.org/10.1016/S2095-3119(14)60887-X)

Carrel, a. (1937). the Culture of Whole Organs : I. Technique of the Culture of the Thyroid Gland. *The Journal of Experimental Medicine*, 65(4), 515–26. <http://doi.org/10.1084/jem.65.4.515>

Churchill, W. S. (1932). *Thoughts and Adventures*. London: Thornton Butterworth.

Coghlan, A. (2011). Meat without slaughter. *New Scientist*, 211(2828), 8–9. [http://doi.org/10.1016/S0262-4079\(11\)62126-X](http://doi.org/10.1016/S0262-4079(11)62126-X)

Corson, W. H. (1994). Changing course: An outline of strategies for a sustainable future. *Futures*, 26(2), 206–223. [http://doi.org/10.1016/0016-3287\(94\)90110-4](http://doi.org/10.1016/0016-3287(94)90110-4)

Datar, I., & Betti, M. (2010). Possibilities for an in vitro meat production system. *Innovative Food Science & Emerging Technologies*, 11(1), 13–22. <http://doi.org/10.1016/j.ifset.2009.10.007>

DeFoliart, G. R. (1992). Insects as human food. *Crop Protection*, 11(5), 395–399. [http://doi.org/10.1016/0261-2194\(92\)90020-6](http://doi.org/10.1016/0261-2194(92)90020-6)

Dennis, R. G., & Kosnik, II, P. E. (2000). Excitability And Isometric Contractile Properties Of Mammalian Skeletal Muscle Constructs Engineered In Vitro. *In Vitro Cellular & Developmental Biology - Animal*, 36(5), 327–335. [http://doi.org/10.1290/1071-2690\(2000\)036<0327:EAICPO>2.0.CO;2](http://doi.org/10.1290/1071-2690(2000)036<0327:EAICPO>2.0.CO;2)

Dodson, M. V, Martin, E. L., Brannon, M. A., Mathison, B. A., & McFarland, D. C. (1987). Optimization of bovine satellite cell-derived myotube formation in vitro. *Tissue & Cell*, 19(2),

159–66. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/3590147>

Dodson, M. V., McFarland, D. C., Martin, E. L., & Brannon, M. A. (1986). Isolation of satellite cells from ovine skeletal muscles. *Journal of Tissue Culture Methods*, 10(4), 233–237. <http://doi.org/10.1007/BF01404483>

Edelman, P. D., McFarland, D. C., Mironov, V. A., & Matheny, J. G. (2005). Commentary: In vitro-cultured meat production. *Tissue Engineering*, 11(5-6), 659–62. <http://doi.org/10.1089/ten.2005.11.659>

Eelen, V. (1998). Industrial Scale Production of Meat From Cell Culture. Retrieved October 24, 2014, from <http://patentscope.wipo.int/search/en/WO1999031222>

FAO. (2011). *Livestock's Long Shadows - Environmental Issues and Options*. Rome: FAO.

Fountain, H. (2013). A Lab-Grown Burger Gets a Taste Test. Retrieved November 7, 2014, from http://www.nytimes.com/2013/08/06/science/a-lab-grown-burger-gets-a-taste-test.html?_r=0

Ghosh, P. (2013). World's First Lab-Grown Burger is Eaten in London. Retrieved from <http://www.bbc.com/news/science-environment-23576143>

Hanbal, A. bin M. bin. (1995). *Al-Musnad*. In S. Al-Arna'ut (Ed.), . Beirut: Muassasah al-Risalah.

Hem, W. M. (1997). Is human culture oncogenic for uncontrolled population growth and ecological destruction ?, 2(11).

Hill, C. (2001). Human Population Numbers As A Function Of Food Supply Russell Hopfenberg 1* And David Pimentel 2, 3(919), 1–15.

Ibn 'Abd al-Barr, Y. bin 'Abdullah I. M. (1993). *al-Istidhkar*. In A. al-M. A. Qal'aji (Ed.), . Beirut and Cairo: Dar Qutaybah and Dar al-Wa'y.

Ibn 'Atiyyah, M. 'Abd al-H. bin G. (2001). *Al-Muharrar al-Wajiz fi Tafsir al-Kitab al-'Aziz*. In A. al-S. 'Abd al-S. Muhammad (Ed.), . Beirut: Dar al-Kutub al-'Ilmiyyah.

Ibn Kathir, I. bin 'Umar bin K. (1999). *Tafsir al-Qur'an al-'Azim*. In S. bin M. Al-Salamah (Ed.), . Riyad: Dar Tibah.

Ibn Mazih, M. bin A. bin 'Abd al-'Aziz. (2004). *al-Muhit al-Burhani fi al-Fiqh al-Nu'mani*. In A. al-K. S. Al-Jundi (Ed.), . Beirut: Dar al-Kutub al-'Ilmiyyah.

Ibn Nujaym, Z. al-D. (t.t.). *No Tial-Bahr al-Ra'iq Sharh Kanz al-Daqa'iq*. Cairo: Dar al-Kutub al-'Arabiyyah al-Kubra.

Jochems, C. E. a, Van der Valk, J. B. F., Stafleu, F. R., & Baumans, V. (2002). The use of fetal bovine serum: Ethical or scientific problem? *ATLA Alternatives to Laboratory Animals*, 30(2), 219–227.

Kuwait, K. W. (1986). al-Dhaba'ih. In al-Mawsu'ah al-Fiqhiyyah al-Kuwaitiyyah (pp. 171–204). Dhat al-Salasil.

Langelaan, M. L. P., Boonen, K. J. M., Polak, R. B., Baaijens, F. P. T., Post, M. J., & van der Schaft, D. W. J. (2010). Meet the new meat: tissue engineered skeletal muscle. *Trends in Food Science & Technology*, 21(2), 59–66. <http://doi.org/10.1016/j.tifs.2009.11.001>

Larsson, S. C., & Wolk, A. (2006). Meat consumption and risk of colorectal cancer: A meta-analysis of prospective studies. *International Journal of Cancer*, 119(11), 2657–2664. <http://doi.org/10.1002/ijc.22170>

Lazennec, G., & Jorgensen, C. (2008). Concise review: adult multipotent stromal cells and cancer: risk or benefit? *Stem Cells (Dayton, Ohio)*, 26(6), 1387–94. <http://doi.org/10.1634/stemcells.2007-1006>

Lu, S. (2012). Gabor Forgacs: In vitro meat – it's what's for dinner! Retrieved October 13, 2014, from <http://blog.tedmed.com/?p=585>

Majah, I. (1998). Kitab al-Dhaba'ih, Bab Dhakah al-Janin Dhakah Ummihi. In Sunan Ibn Majah. Beirut: Dar al-Jil.

Manzur, I. (t.t.). Lisan al-Arab. In Al-Kabir & A. Ali (Eds.), . Kaherah: Dar al-Maarif.

May, A. (2012). In Vitro Meat: Protein for Twelve Billion.

McFarland, D. C., Doumit, M. E., & Minshall, R. D. (1988). The turkey myogenic satellite cell: optimization of in vitro proliferation and differentiation. *Tissue & Cell*, 20(6), 899–908. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/3245037>

Mironov, V., Boland, T., Trusk, T., Forgacs, G., & Markwald, R. R. (2003). Organ printing: computer-aided jet-based 3D tissue engineering. *Trends in Biotechnology*, 21(4), 157–61. [http://doi.org/10.1016/S0167-7799\(03\)00033-7](http://doi.org/10.1016/S0167-7799(03)00033-7)

NASA. (1998). Small Business Innovative Research (SBIR). Retrieved November 7, 2014, from <http://sbir.gsfc.nasa.gov/SBIR/abstracts/98/sbir/phase1/SBIR-98-1-09.05-6812.html>

Orzechowski, A. (2015). Artificial meat? Feasible approach based on the experience from cell culture studies. *Journal of Integrative Agriculture*, 14(2), 217–221. [http://doi.org/http://dx.doi.org/10.1016/S2095-3119\(14\)60882-0](http://doi.org/http://dx.doi.org/10.1016/S2095-3119(14)60882-0)

Post, M. J. (2012). Cultured meat from stem cells: challenges and prospects. *Meat Science*, 92(3), 297–301. <http://doi.org/10.1016/j.meatsci.2012.04.008>

Post, M. J. (2014). Cultured beef: medical technology to produce food. *Journal of the Science of Food and Agriculture*, 94(6), 1039–1041. <http://doi.org/10.1002/jsfa.6474>

Powell, R. L., Dodson, M. V., & Cloud, J. G. (1989). Cultivation and differentiation of satellite cells from skeletal muscle of the rainbow trout *Salmo gairdneri*. *Journal of Experimental Zoology*,

250(3), 333–338. <http://doi.org/10.1002/jez.1402500314>

Qudamah, I. (1996). *al-Sharh al-Kabir*. In A. bin ‘Abd al-M. Al-Turki (Ed.), . Giza: Hajar li al-Tiba‘ah.

Qudamah, I. (1997). *al-Mughni*. In A. bin ‘Abd al-M. Al-Turki & A. al-F. M. Halw (Eds.), . Riyadh: Dar ‘Alam al-Kutub.

Russell, P. S., & Giner-Sorolla, R. (2011). Moral anger, but not moral disgust, responds to intentionality. *Emotion*, 11(2), 233–240. <http://doi.org/10.1037/a0022598>

Rusyd, I. (1988). *al-Bayan wa al-Tahsil wa al-Sharh wa al-Tawjih wa al-Ta“lil fi Masa”il al-Mustakhrajah*. In A. Al-Habbabi (Ed.), . Beirut: Dar al-Gharb al-Islami.

Schneider, Z. (2012). In Vitro Meat: Space Travel, Cannibalism, and Federal Regulation. *Houston Law Review*, 50. Retrieved from <http://heinonline.org/HOL/Page?handle=hein.journals/hulr50&id=1015&div=&collection=journals>

Schneider, Z. (2013). 50:3 In Vitro Meat: Space Travel, Cannibalism, and Federal Regulation |. Retrieved October 7, 2015, from <http://www.houstonlawreview.org/2013/04/09/503-in-vitro-meat-space-travel-cannibalism-and-federal-regulation/>

Seale, P., & Rudnicki, M. a. (2000). A New Look at the Origin, Function, and “Stem-Cell” Status of Muscle Satellite Cells. *Developmental Biology*, 218(2), 115–124. <http://doi.org/10.1006/dbio.1999.9565>

Smith, F. E. (1930). *The World in 2030 A.D.* London: Hodder and Stoughton.

Song, Y., Manson, J. E., Buring, J. E., & Liu, S. (2004). A prospective study of red meat consumption and type 2 diabetes in middle-aged and elderly women: the women’s health study. *Diabetes Care*, 27(9), 2108–15. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/15333470>

Specter, M. (2011). Test-tube Burgers. Retrieved November 6, 2014, from <http://www.newyorker.com/magazine/2011/05/23/test-tube-burgers>

Tuomisto, H. L., & de Mattos, M. J. T. (2011). Environmental impacts of cultured meat production. *Environmental Science & Technology*, 45(14), 6117–23. <http://doi.org/10.1021/es200130u>

Tuomisto, H., & Roy, A. (2012). Could cultured meat reduce environmental impact of agriculture in Europe? 8th International Conference on LCA in ..., (October), 2–4. Retrieved from <http://www.mdpi.com/2076-2615/3/3/647>
http://www.researchgate.net/publication/255179690_Could_cultured_meat_reduce_environmental_impact_of_agriculture_in_Europe/file/504635200b0f43e488.pdf

Vandenburgh, H., Del Tatto, M., Shansky, J., Lemaire, J., Chang, A., Payumo, F., ... Raven, L. (1996). Tissue-engineered skeletal muscle organoids for reversible gene therapy. *Human Gene Therapy*, 7(17), 2195–2200. <http://doi.org/10.1089/hum.1996.7.17-2195>

Wagers, A. J., & Weissman, I. L. (2004). Plasticity of adult stem cells. *Cell*, 116(5), 639–48.

Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/15006347>

Weiss, F., & Leip, A. (2012). Greenhouse gas emissions from the EU livestock sector: A life cycle assessment carried out with the CAPRI model. *Agriculture, Ecosystems & Environment*, 149, 124–134. <http://doi.org/10.1016/j.agee.2011.12.015>

WHO. (2014). Urban Population Growth. Retrieved October 3, 2014, from http://www.who.int/gho/urban_health/situation_trends/urban_population_growth_text/en/

Wilschut, K. J., Jaksani, S., Van Den Dolder, J., Haagsman, H. P., & Roelen, B. A. J. (2008). Isolation and characterization of porcine adult muscle-derived progenitor cells. *Journal of Cellular Biochemistry*, 105(5), 1228–39. <http://doi.org/10.1002/jcb.21921>

Wilson, S. (2013). World population to reach 9.7 billion by 2050 new study predicts. Retrieved October 3, 2014, from <http://www.telegraph.co.uk/earth/10348822/World-population-to-reach-9.7-billion-by-2050-new-study-predicts.html>

Yablonka-Reuveni, Z., Quinn, L. S., & Nameroff, M. (1987). Isolation and clonal analysis of satellite cells from chicken pectoralis muscle. *Developmental Biology*, 119(1), 252–9. Retrieved from <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4128172&tool=pmcentrez&rendertype=abstract>

Zaraska, M. (2013). Lab-Grown Beef Taste Test: “Almost” Like a Burger. Retrieved November 7, 2014, from http://www.washingtonpost.com/national/health-science/lab-grown-beef-taste-test-almost-like-a-burger/2013/08/05/921a5996-fdf4-11e2-96a8-d3b921c0924a_story.html